CAPE BRETON DEVELOPMENT CORPORATION

COAL-WATER FUEL CONVERSION OF AN INDUSTRIAL OIL-DESIGNED PACKAGE BOILER IN A PULP AND PAPER PLANT, HANTSPORT, N.S.

(PART OF A PROGRAM OF THE FEDERAL PANEL ON ENERGY RESEARCH AND DEVELOPMENT (PERD))

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FINAL REPORT

by

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TABLE OF CONTENTS

Page

i ACKNOWLEDGEMENTS

ii EXECUTIVE SUMMARY

1.0 Introduction 1

2.0 Organizational Background 3
  2.1 The Minas Basin Pulp & Power Company Ltd. 3
  2.2 The Cape Breton Development Corporation 4

3.0 Design and Planning 6

4.0 Boiler Conversion and Operation 8
  4.1 Construction and Installation 8
  4.2 Commissioning 13
  4.3 #7 Boiler Operation 13
  4.4 Project Costs 15

5.0 Technical Discussion 18
  5.1 Data Acquisition 18
  5.2 Tertiary Air Ports 18
  5.3 Primary Air Car Enlargement 19
  5.4 Tertiary Damper Air Control 19
  5.5 CWF Flyash Characterization 20
  5.6 Emissions Testing 20
  5.7 Particulate Cleanup 22
  5.8 Boiler Inspections 22

6.0 Conclusions 25
  6.1 CWF Production and Handling 25
  6.2 Boiler Conversion and Operation 27
  6.3 Burner Atomizer Performance 28
  6.4 Overall Economics 28

LIST OF TABLES

Table I: Cost Estimation
Table II: Proposed Cost Sharing Scheme
Table III: Operating Hours on #7 Boiler
Table IV-A: Costs for the MBP&P CWF Conversion Project
Table IV-B: Conversion Costs for the Boiler
Table V: EMR Emission Test Results - Typical

LIST OF FIGURES

Figure I: CWF Plant Flowsheet
Figure 2: Package Boiler Location Diagram
Figure 3: Illustration of the CANMET/NRC Burner and Atomizer
Figure 4: Simplified CWF Supply Piping Diagram
Figure 5: Simplified CWF Burner Piping Diagram
Figure 6: Monthly CWF Shipments to MBP&P

APPENDICES

A - Original CBDC Proposal to CANMET
B - Tender Document
C - Progress Reports
D - Drawings
E - Minutes of the Technical Steering Committee
F - Minutes of the Technical Sub-Committee
G - Project Events and Milestones
H - Photographs
I - Operator Log Sheets
J - NSRF CWF Flyash Characterization Report
K - EMR-CANMET CWF Flyash Characterization Report
L - EMR Emissions Test Data
M - Emissions Data Plots
N - CWF Delivery Records and Analyses
O - Ceramic Wear Records

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The execution of this program was monitored by a Technical Steering Committee comprising representatives of the following organizations: Energy, Mines and Resources Canada (EMR), Nova Scotia Department of Mines and Energy (N.S.D.M.E.), CANMET, OSF, CBDC, and MBP&P. Also, a Technical Sub-Committee was organized to monitor site-specific and technical details. This committee consisted of members from the following organizations: National Research Council of Canada (NRCC), MBB Mechanical Services Ltd. (MBB), CANMET, CBDC, and MBP&P.

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EXECUTIVE SUMMARY

In early 1987 work was completed on conversion of an oil-designed package type boiler to burn coal-water fuel (CWF) in an industrial setting. Steam produced from the boiler is used in two process plants, Canada Keyes Fibre (CKF) and Minas Basin Pulp and Power (MBP&P), both located in Hantsport, Nova Scotia. The boiler is situated on the MBP&P site. The coal-water fuel is supplied by Cape Breton Development Corporation (CBDC).

The objective of this commercial demonstration was to successfully transfer coal-water fuel combustion technology to industry from the R&D sector, thereby proving its technical and commercial viability.

After commissioning, the project included several system modifications to improve both combustion performance and fuel handling techniques. As well, during the project a number of studies were conducted including emissions rate measurement and flyash characterization. Extremely valuable and revealing information has been obtained as a result of these modifications and studies.

In general, the project has successfully demonstrated the technical feasibility of CWF combustion in a commercial industrial boiler. Unfortunately, the low world oil price prohibits any further commercial exploitation of CWF at the present time and budgetary constraints imposed on all of the project's funding organizations have curtailed Canada's first commercial application of CWF technology.

SOMMAIRE EXECUTIF

Tout dans l'anneé 1987 un projet fut completé sur la conversion d'un chaudière à l'huile à un qui utilizerait un mélange de charbon et eau (CWF) dans une installation industrielle. La vapeur produit au chaudiere est utilise en deux usines, Canada Keyes Fibre (CKF) et Minas Basin Pulp and Paper (MBP&P), toutes les deux situeés à Hantsport, Nouvelle Ecosse. Le chaudière est situeés ou MBP&P est logée. Le carburant de charbon-eau est vendue par la Societé de Développement du Cap-Breton (SDCB).

L'objectif de cette demonstration commerciale était pour transferer avec succès la technologie de brûler ce carburant de charbon-eau, de la researche à l'industrie, donnant la preuve de son succès du point de veu technique et commerciale.

Apres sa commission, le projet inclus beaucoup de changes au system pour augmenter sa performance à brûler et à manipuler le carburant dans le systèime. Aussi, durant le projet plusieurs études eut lieu qui inclus le mésurement de vitesse d'émission et du charactère du 'flyash'. De vraiment importantes informations a été découvertes de les résultants de ses modifications et études.

En géneral, le projet était un succès à démontrer les possibilités techniques de utilizer CWF dans un chandière industrielle et commerciale. C'est dommage, que le prix d'huile mondiale est si bas qu'il empêche d'autre utilization commerciale de CWF à présent et les contraintes du budget imposés sur toutes les organizations supportant ce projet financrièrement ont arrêtés la premiere application commerciale de technologie CWF au Canada.

1.0 Introduction

Coal Slurry Fuel (CSF) development and demonstration work began in Eastern Canada in the late 1970's. The objective was to provide a coal-based fuel and a combustion technology as an alternative to expensive heavy fuel oil (HFO). Early work was with Coal-Oil Mixtures (COM), typically 50% coal and 50% oil. However, economics indicated that more complete oil displacement was necessary for it to be competitive.

In the early 1980's the technology of Coal-Water Fuel (CWF) became of interest. It had the advantage of having no oil in the formulation; CWF typically contains 70% coal, 30% water and a small amount of chemical additives to impart fluidity and stability. At that particular time oil prices were relatively high, and rising. The federal National Energy Policy encouraged programs to displace imported oil in Atlantic Canada. It was under this Special Atlantic Initiatives Coal Utilization Program that CWF development and demonstration started in 1982. By 1983, CWF production by the Cape Breton Development Corporation (CBDC), using the patented Carbogel technology and CWF combustion by the New Brunswick Electric Power Commission, Chatham Generating Station, was underway. This demonstration, in two coal-designed boilers which had been converted to oil-firing, led to significant refining of the CWF technology.

In 1985 CBDC provided Carbogel CWF to the Iron Ore Company of Canada (IOCC) for a 30-day trial in an iron ore pellet induration furnace. This again was an oil-substitution application, and it further proved the technical viability of CWF.

As a follow-up to the Chatham demonstration, a program was implemented in 1986 for conversion of a HFO-designed utility boiler at Maritime Electric Company Limited (MECL) in Charlottetown, Prince Edward Island. This project, under federal government funding was another successful demonstration of CWF.

During this time of CWF development several studies were done. These involved marketing, feasibility and commercial plant design. Also, during this time, oil prices fell and the market outlook subsequently declined. The economics of industrial applications looked more promising than utility conversions, so CBDC pursued this route in looking for growth opportunities for CWF.

In 1987 a contract was signed between CBDC and Minas Basin Pulp & Power (MBP&P) for a 2-year commercial demonstration using CWF as the primary fuel source in a steam generating boiler.

As part of this program, MBP&P installed a 60,000 lb./hr. oil-designed package boiler to replace older vintage boilers and provide process steam to their own plant plus the neighboring Canada Keys Fibre plant. Through funding assistance from Energy, Mines and Resources' CANMET Labs, the Canada Nova Scotia Oil Substitution Fund and the Cape Breton Development Corporation (CBDC), the boiler installation can burn CWF produced by CBDC in Cape Breton and employs the CWF burner technology developed jointly by EMR, NRCC and CBDC.

Under the terms of an agreement between CBDC and EMR Canada (DSS contract #23440-7-9014/01-SG), this final report for the project has been prepared. It represents an overview of the activities undertaken by this project. The report outlines the boiler installation through to operation, with detailed discussion of various technical aspects. A comprehensive appendices is attached providing much of the associated requirements for the report.

2.0 Organizational Background

In 1986 CBDC made an effort to find a commercial application for CWF. Market conditions indicated that an industrial application would be the most suitable, for example a pulp and paper mill. Although oil prices had fallen from their peak in the early 1980's, industrial users (as opposed to large utilities) were not paying the lowest price for HFO. In September of that year MBP&P were approached by CBDC and introduced to the possibility of displacing heavy fuel oil requirements with Carbogel CWF. A proposal was made to CANMET for financial support (see Appendix A) and funding was secured from the OSF. Conditions for a conversion at MBP&P were such that they agreed to a program to burn CWF.

2.1 The Minas Basin Pulp and Power Company Limited

The Minas Basin Pulp and Power Company Limited is located in Hantsport, Nova Scotia, on the shores of Minas Basin, approximately 75 Km from Halifax. In 1929, MBP&P began producing pulp for export to the U.S.A., at the rate of 5000 tons per year. By 1938 production had reached 20,000 tpy and over the next 40 years MBP&P diversified its interests and investments to include association with or acquisition of companies engaged in lumbering, shipping, corrugated carton manufacturing, selling building supplies, developing real estate and food growing and processing.

In addition to supplying pulp as feedstock for the neighboring Canadian Keyes Fibre (CKF) plant, where a variety of molded paper products are produced, MBP&P operates a paper mill with an average daily production of 100 tons of linerboard material. Process steam requirements for both CKF and MBP&P are supplied from a six-boiler steam plant owned and operated by Minas Basin Pulp and Power. The boilers, two of which are wood fired, are all of a package type and range in age from 40 to 19 years. Average steam load is in the range of 30,000 - 40,000 lb./hr. on a continuous basis.

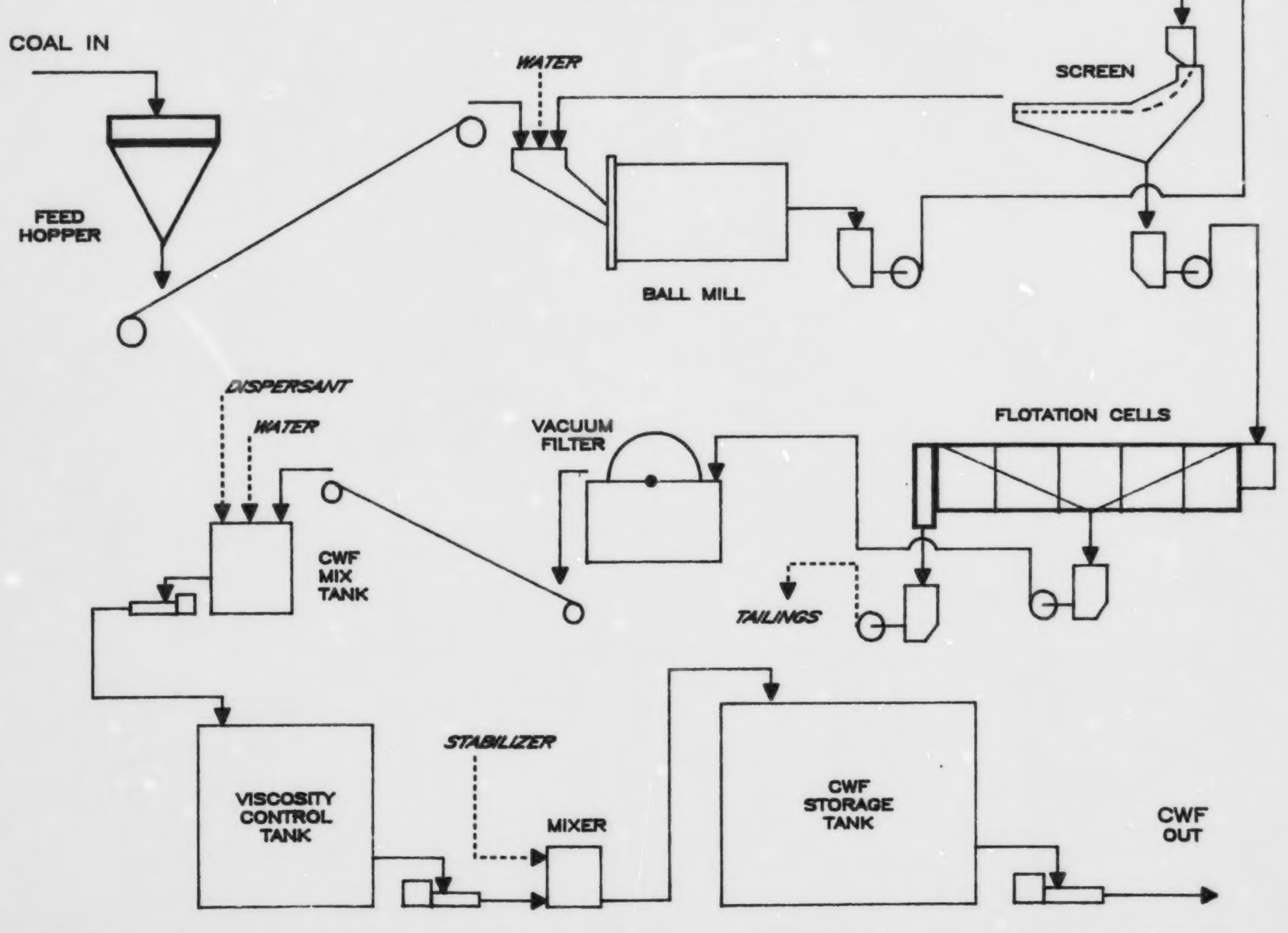
2.2 The Cape Breton Development Corporation

CBDC and its predecessors have been in the coal mining business for about 100 years. Mining technology has certainly changed over those years, and to some degree utilization technology has changed as well. Utilization methods, however, have not undergone a major change; there has been, in fact, a loss in markets to liquid hydrocarbon fuels.

CWF is a coal-based fuel that is intended to reverse the shift to oil. It has most of the advantages of liquid fuels, and also has few of the disadvantages of coal as a traditional fuel. CBDC embarked on its development of CWF in 1982 when it signed a license agreement with AB Carbogel of Sweden for its patented CWF technology.

In 1983 CBDC began operation of a 4-tph CWF pilot production plant. CWF is produced by finely grinding coal, beneficiating the ground coal to remove impurities, and then adding chemical additives to make a stable, high solids concentration of coal in water. The original 4-tph plant has been upgraded to about 8 tph; the flowsheet is shown in Figure 1.

FIGURE 1. CWF PLANT FLOWSHEET


COAL IN
FEED HOPPER
WATER
BALL MILL
SCREEN
DISPERSANT
WATER
CWF MIX TANK
VACUUM FILTER
FLOTATION CELLS
TAILINGS
STABILIZER
VISCOSITY CONTROL TANK
MIXER
CWF STORAGE TANK
CWF OUT

3.0 Design and Planning

By the summer of 1987, agreement in principle had been reached and funding assistance procured for installation of a 60,000 lb./hr. package boiler at MBP&P converted to burn CWF, for up to two-years. The contract structure is described in the original project proposal which is included in Appendix A. The total cost of the CWF conversion project including engineering, capital cost of equipment, installation and commissioning, manpower for planning, and supervision and monitoring of system performance was estimated at $2,130,000. A breakdown of this estimation is shown in Table I.

TABLE I: COST ESTIMATION

Cost Element	Estimate
Equipment, installation and commissioning	$ 757,900
Engineering	113,000
Coal	1,260,000
Total Project Cost	$ 2,130,900

The CBDC engineering component ($113,000.) represents approximately 15% of the estimated equipment and installation cost. The coal component is calculated on a present day fair market value for thermal coal of $50 per tonne. Twelve thousand and six hundred (12,600) tonnes of coal per year for two years would be required to produce an estimated 36,000 t of CWF. The coal cost does not constitute any portion of the fuel price to Minas Basin Pulp and Power in order that the CWF may be sold to MBP&P at an equivalent oil price. Such a pricing strategy, critical to project approval by MBP&P, covers only the processing and transportation costs and the cost of the coal thus becomes a cost to the project. The cost sharing that was proposed is shown in Table II.

Tenders for the CWF conversion project were called for by CBDC in early 1987. The tender for prime contractor was awarded to MBB Mechanical Services Limited on July 31, 1987. The CWF site preparation contract was awarded to J.W. Lindsay Enterprises, and the soils study contract was awarded to Jacques Whitford and Associates Ltd., both by MBP&P.

TABLE II - PROPOSED COST SHARING SCHEME

Contributor	
CBDC	1,373,000
MBP&P	100,000
OSF	300,000
OSF (Interest)	57,900
CANMET	300,000
Total Project Cost	2,130,900

Other sub-contractors participating in the CWF conversion project are listed below:

George Brandy's and Assoc.	Foundation Design
Saleway Construction	Install concrete Foundations
Lonthier Construction	Excavation & Back-filling
Bailey Controls Company	Boiler Controls
T.J. Inspection Services	Inspection of all internal Welds
Mobil Valves	Soot Blower Fabrication
Archie's Welding	Install BFW Tank & Water Softener
Gordon's Welding	Install Steamheader Extension and Deaerator
Speedy Propane	Install Five 40 gal. Propane tanks.

A program was developed to acquire a used 60,000 lb./hr. package boiler available from the Atomic Energy of Canada Limited (AECL) Heavy Water Plant in Glace Bay, N.S., (see photos H-1 to H-4, Appendix H), install it at the MBP&P plant, and convert it to burn CWF for a minimum two year period. The boiler would be tied in to existing plant steam lines at Minas to supply 100% of MBP&P's steam requirements on a continuous basis. This would enable conversion to CWF with minimal interruption to the steam supply - a critical prerequisite since the plant supplies process steam requirements for two industries operating 24 hr./day.

Dismantling of the boiler, stack, and auxiliary equipment and their preparation for transport to the MBP&P site is described in Progress Report #1, Appendix C. Conversion of the boiler to burn CWF required modifications of the boiler front including new refractory and a new burner assembly. The new burner included a CANMET/NRC steam atomizing CWF burner, similar to the unit developed as a result of the Chatham, N.B. burner development work by CANMET and NRC. Modifications necessay to convert the boiler to burn CWF are described in the Progress Reports in Appendix C, with drawings in Appendix D. Also, much of the relevant information on the project in general is contained in the Minutes of the Technical Steering Committee and Minutes of the Technical Sub-Committee, which are attached as Appendix E and Appendix F respectively.

4.0 Boiler Conversion and Operation

The installed boiler system consists of a 1973 B&W Type FM 60,000 lb./hr. package boiler converted to burn CWF or HFO, a fuel supply system for CWF and HFO, combustion air and exhaust gas handling equipment, ancilliary steam production equipment and a data acquisition system.

Work on the boiler installation began in the fall of 1987. The boiler was first fired on HFO on March 26, 1988 and initial CWF firing was on April 11, 1988. A detailed breakdown of the prlject events and milestones is presented in Appendix G. Photographs associated with various stages of the project are contained in Appendix H. A description of the project is given here.

4.1 - Construction and Installation

The site for the new boiler (designated #7 Boiler) was selected next to the #6 Boiler. This required construction of a new boilerhouse, stack foundation and locations for ancilliary equipment. The area was excavated and piles were driven to allow for the foundations. The layout is shown in Figure 2. Photos are included in Appendix H (Photos H-5 to H-8).

Modifications to the boiler were limited to the windbox and installation of a side wall viewport for observing the primary combustion zone in the furnace (See Photo H-9, Appendix H). Windbox modifications enabled the installation of the CANMET Model 1000 CWF burner and NRCC CWF atomizer (see photo H-12, Appendix H). This included a new burner throat refractory quarl on the boiler front wall (see photo H-10, Appendix H). The air register and atomizer are shown in Figure 3. A description of the CANMET/NRC burner and atomizer can be found in Progress Report #3, Appendix C.

The CWF supply system consists of a centrifugal off-loading pump, two 20,000 gal. (*76 m^3) indoor storage tanks, a 16 gpm (72 lpm) variable speed progressive cavity positive displacement pump, a fuel screen set and instrumentation for measuring flow, pressure and temperature. This system is shown in Figure 4. HFO is supplied to the burner front via a conventional HFO delivery system. The burner front configuration is illustrated in Figure 5.

Ancilliary steam production equipment includes deaerator, feedwater pumps, chemical tanks, blowdown tank, numerous

FIGURE 2. PACKAGE BOILER LOCATION DIAGRAM

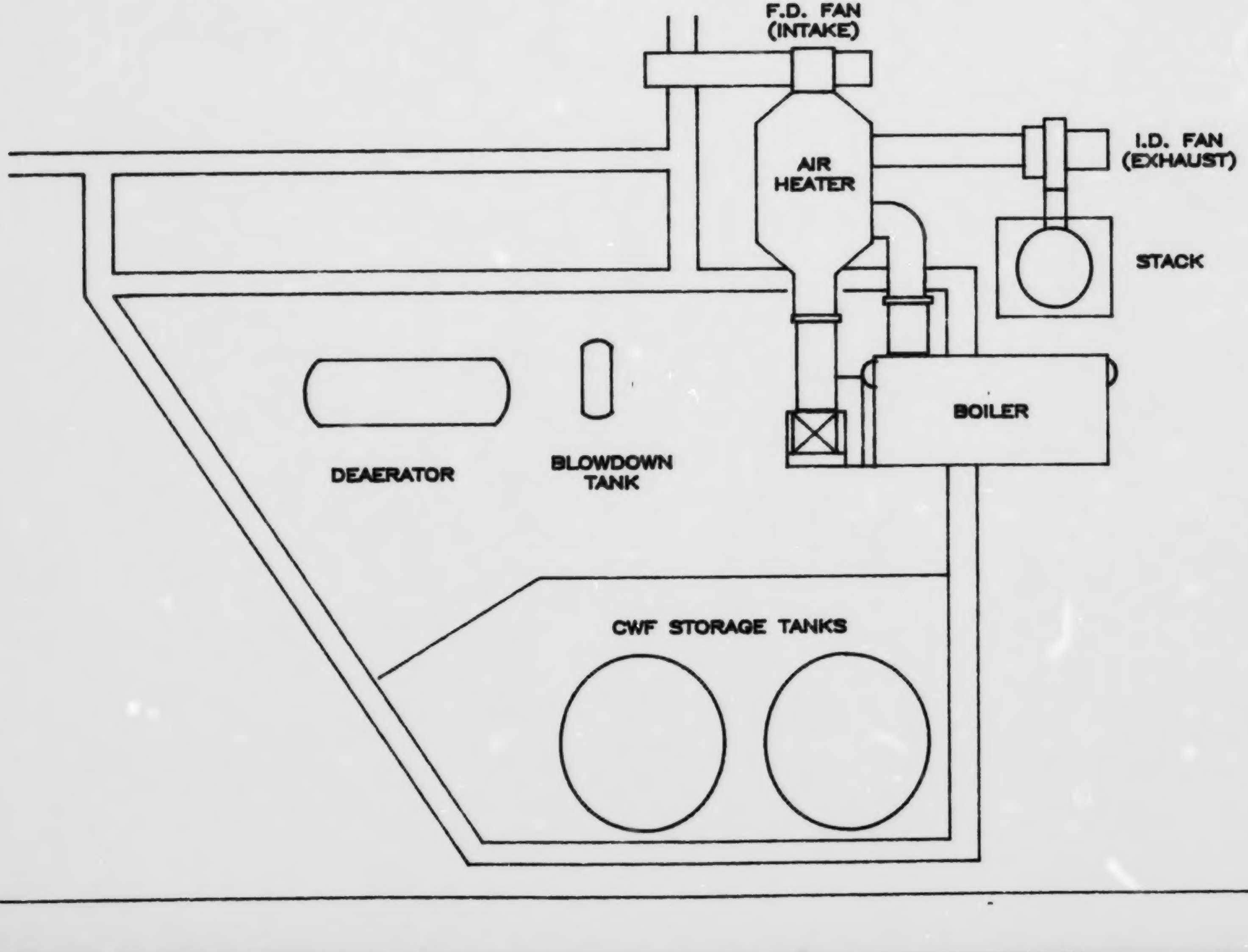
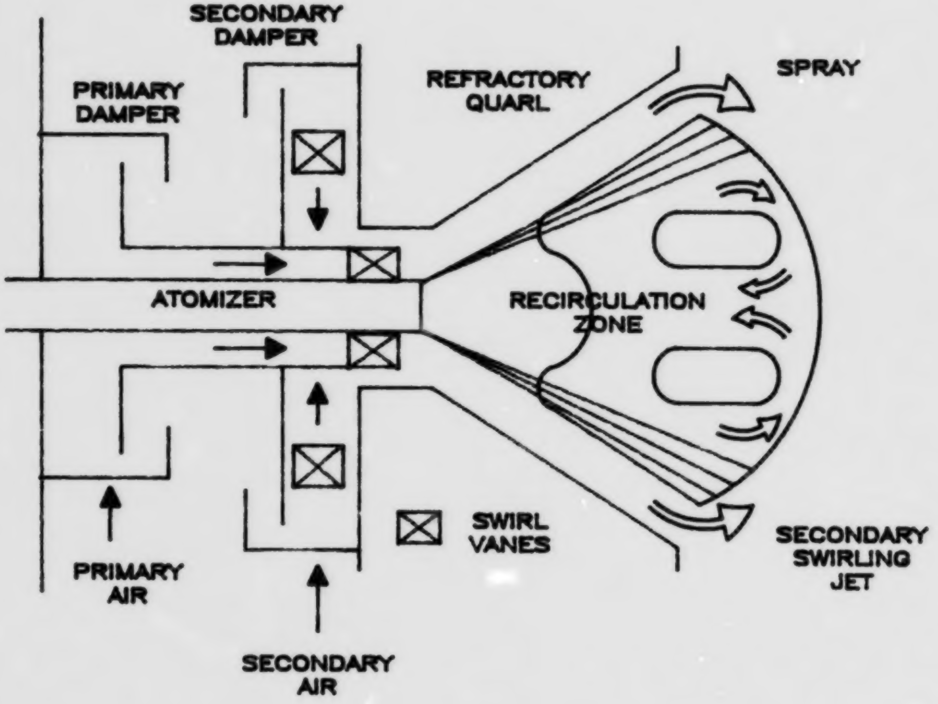
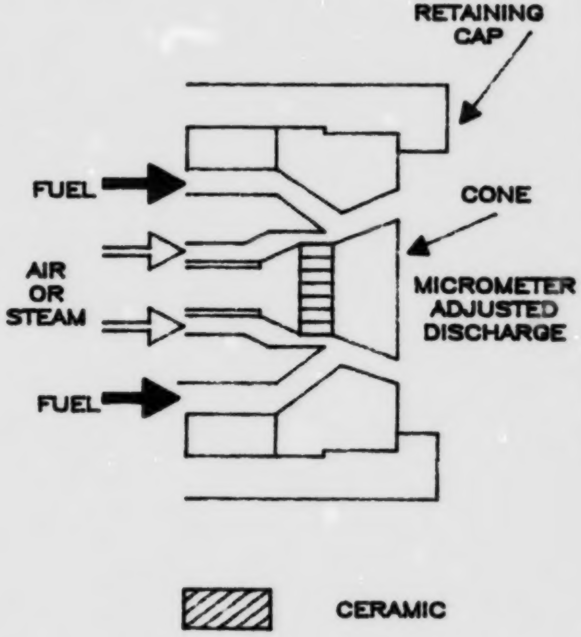

F.D. FAN
(INTAKE)
AIR
HEATER
I.D. FAN
(EXHAUST)
STACK
BOILER
DEAERATOR
BLOWDOWN
TANK
CWF STORAGE TANKS

FIGURE 3. ILLUSTRATION OF THE CANMET/NRC BURNER AND ATOMIZER


SECONDARY DAMPER
PRIMARY DAMPER
REFRACTORY QUARL
SPRAY
ATOMIZER
RECIRCULATION ZONE
SWIRL VANES
PRIMARY AIR
SECONDARY AIR
SECONDARY SWIRLING JET

CANMET BURNER REGISTER, QUARL AND FLOW PATTERNS


RETAINING CAP
FUEL
CONE
AIR OR STEAM
MICROMETER ADJUSTED DISCHARGE
FUEL
CERAMIC

NRC DUAL FUEL ATOMIZER

FIGURE 4. SIMPLIFIED CWF SUPPLY PIPING DIAGRAM

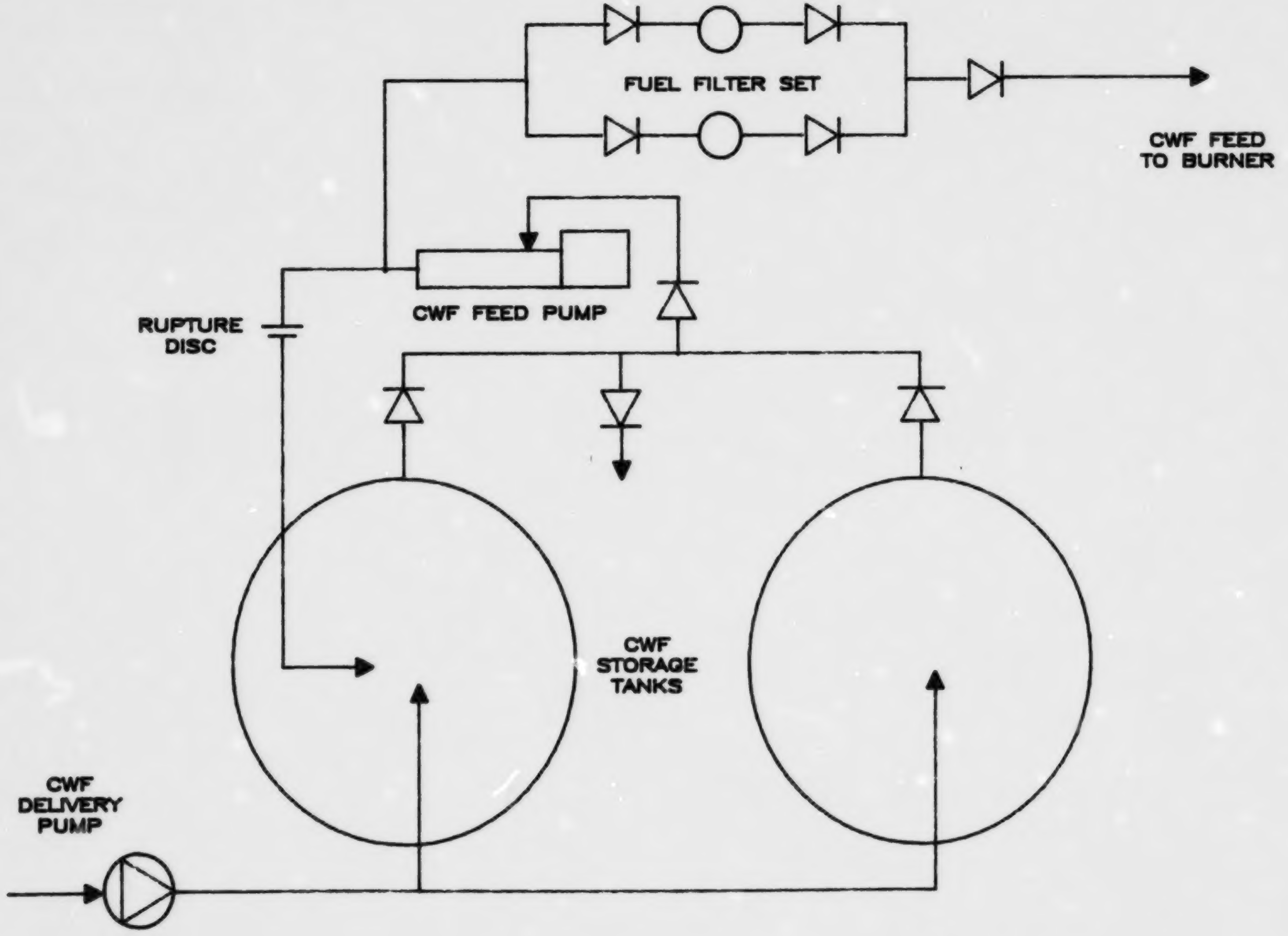
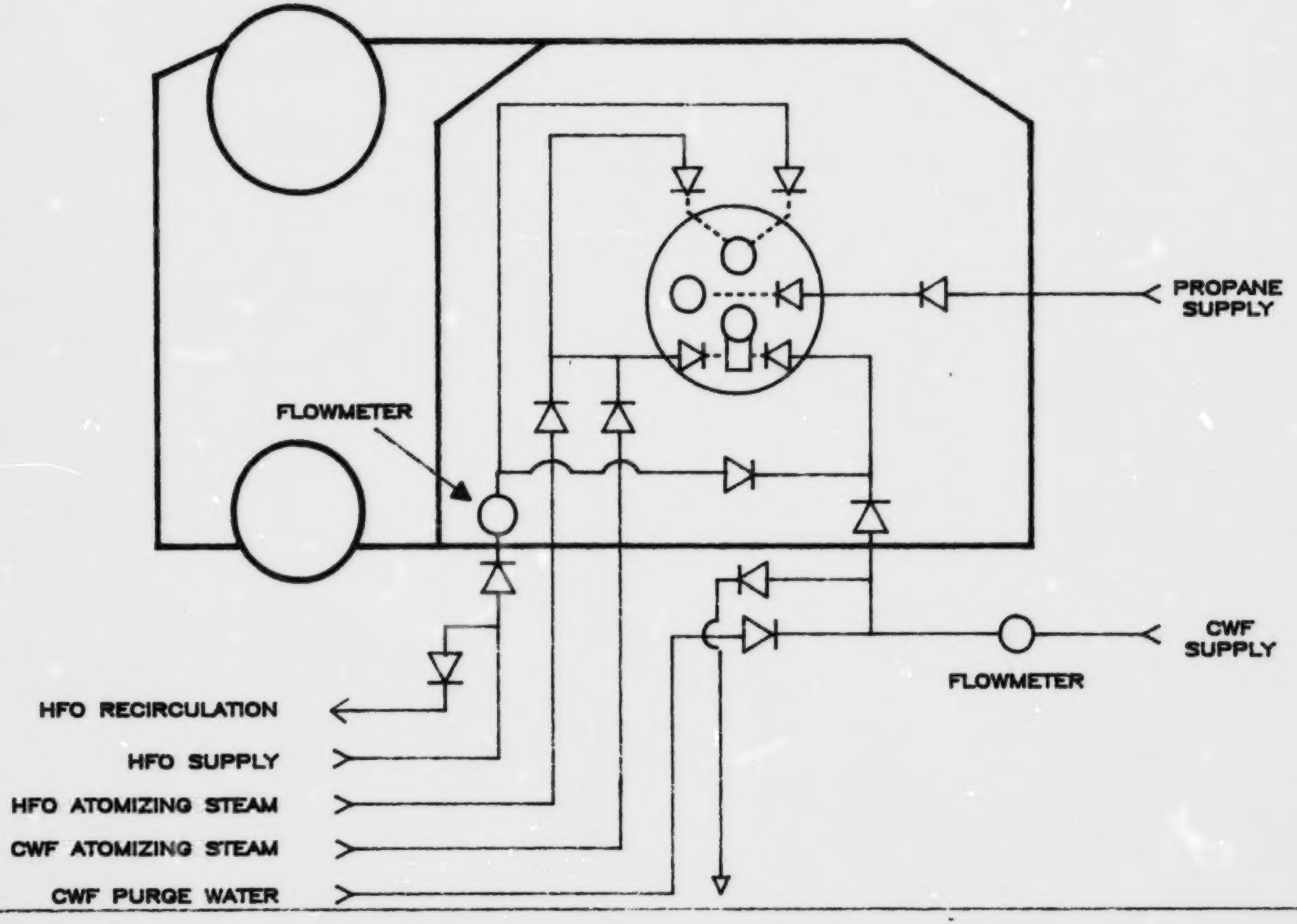

FUEL FILTER SET
CWF FEED
TO BURNER
CWF FEED PUMP
RUPTURE
DISC
CWF
STORAGE
TANKS
CWF
DELIVERY
PUMP

FIGURE 5. SIMPLIFIED CWF BURNER PIPING DIAGRAM


FLOWMETER
PROPANE SUPPLY
CWF SUPPLY
FLOWMETER
HFO RECIRCULATION
HFO SUPPLY
HFO ATOMIZING STEAM
CWF ATOMIZING STEAM
CWF PURGE WATER

automatic valves and instrumentation for flow, pressure and temperature indication. A tubular air heater is used to preheat combustion air using the exhaust gas. Steam produced by the #7 boiler is piped into an existing 8 inch steam header at 150 psig. Process and heating steam is distributed to the two plants on the site.

A burner management system was also part of the installation. It is controlled by a Bailey Network 90 system with full control/display backup available on an IBM-AT microcomputer. Automatically activated valves enable startup, fuel switching and shutdown to be safely controlled from the operator interface unit (OIU) in the control room. A detailed discussion of the #7 boiler opration is included in the Technical Sub-Committee meeting of 1988-01-15, Appendix F.

The installation was essentially complete in March, 1988 and commissioning began.

4.2 Commissioning

Initial start-up of the #7 boiler was on HFO. There was considerable foreign material encountered in the atomization steam line and this caused some delays. After about two weeks the boiler was operating smoothly on HFO, but a strainer had to be installed in the atomizing steam line.

Upon inspection of the boiler some separation of the new and old refractory was noticed in the burner throat area. This was packed with kaowool insulation.

The first firing with CWF was not entirely successful. Atomization appeared good, but the ignitor was found to be too small. However, continued efforts yielded smooth switchover from HFO to CWF and relatively consistent operation was achieved. After several weeks of dealing with routine start-up problems and making minor adjustments, the boiler commissioning was complete.

4.3 #7 Boiler Operation

The #7 Boiler was typically started up on oil and switched over to CWF when combustion air temperature was sufficiently high (minimum 400°F). The combustion air is preheated downstream of the Forced Draft (FD) fan by a 3-pass tubular air heater equipped with a steam coil heater in the air inlet side. Exhaust gases are drawn from the boiler exit and through the air heater by the Induced Draft (ID) fan. Discharge is into an 80-foot steel stack that has a sampling platform and ports for emissions testing.

The dual-fuel capability of the burner/atomizer allowed fuel switching during operation. Once the boiler was running, it was the primary source of steam production for the MBP&P and CKF plants.

A major modification was made in early May. This was the drilling of a series of holes to allow tertiary air into the boiler (see Section 5.2). This gave more stable firing and extended the firing range for CWF. For the next two months the most consistent and prolonged burning of CWF was done.

In early July another modification was made. This was the installation of a larger primary air can in the burner and an air straightener in the windbox (see Section 5.3). Shortly after this change a set of boiler performance tests were done by CANMET (see Section 5.6). Operation of the #7 boiler soon became very unstable on CWF; proper ignition could not be achieved. The smaller primary air can was reinstalled and the air straightener was partly removed. This reversed the ignition and stability problem, but during the month of July much less CWF was burned than in June. Also, the poor combustion during July aggravated the particulate emission problem. Particulate fallout within the town resulted in the decision by MBPP management not to burn CWF when the wind was blowing over the town.

Operation continued in this mode, i.e. burning CWF only when the wind was not over the town. In late September an ash characterization test program was conducted (see Section 5.5). Some further boiler modifications were made in mid-October (see Section 5.4). Following these modifications, which included addition of a tertiary air annulus to the burner, the operating range was shifted upward and tertiary damper adjustment was necessary to get good low-end firing. Emission testing was conducted by Ortech International in early November (see Section 5.6).

By late November some concerns with the control logic led to the decision by MBP&P to shut down the #7 boiler and make the necessary logic modifications. This, plus the current low price of oil, resulted in curtailment of CWF production by CBDC. It was decided to supply MBP&P from inventory. However, the extended shutdown of the #7 boiler (about 3 months), continuing low oil prices, and some difficulties in establishing stable CWF burning conditions upon resumption of operation further affected the project. About 100 tonnes of CWF were burned in March, 1989 (the only burn since November, 1988). Eventually, economic conditions caused the complete shutdown of the CWF plant by CBDC in May.

The operation of the #7 boiler from March to November, 1988 used about 3600 tonnes of CWF. Another 100 tonnes was burned in March, 1989. The monthly deliveries of CWF to MBP&P are shown in Figure 6. The hours of operation on CWF and HFO are given in Table III. The dramatic drop in CWF consumption in July was due to the problems resulting from the modifications made to the primary air can; when these changes were reversed, CWF consumption increased. However, the lack of a particulate cleanup system eventually reduced the rate of CWF burning as well.

TABLE III: OPERATING HOURS ON #7 BOILER

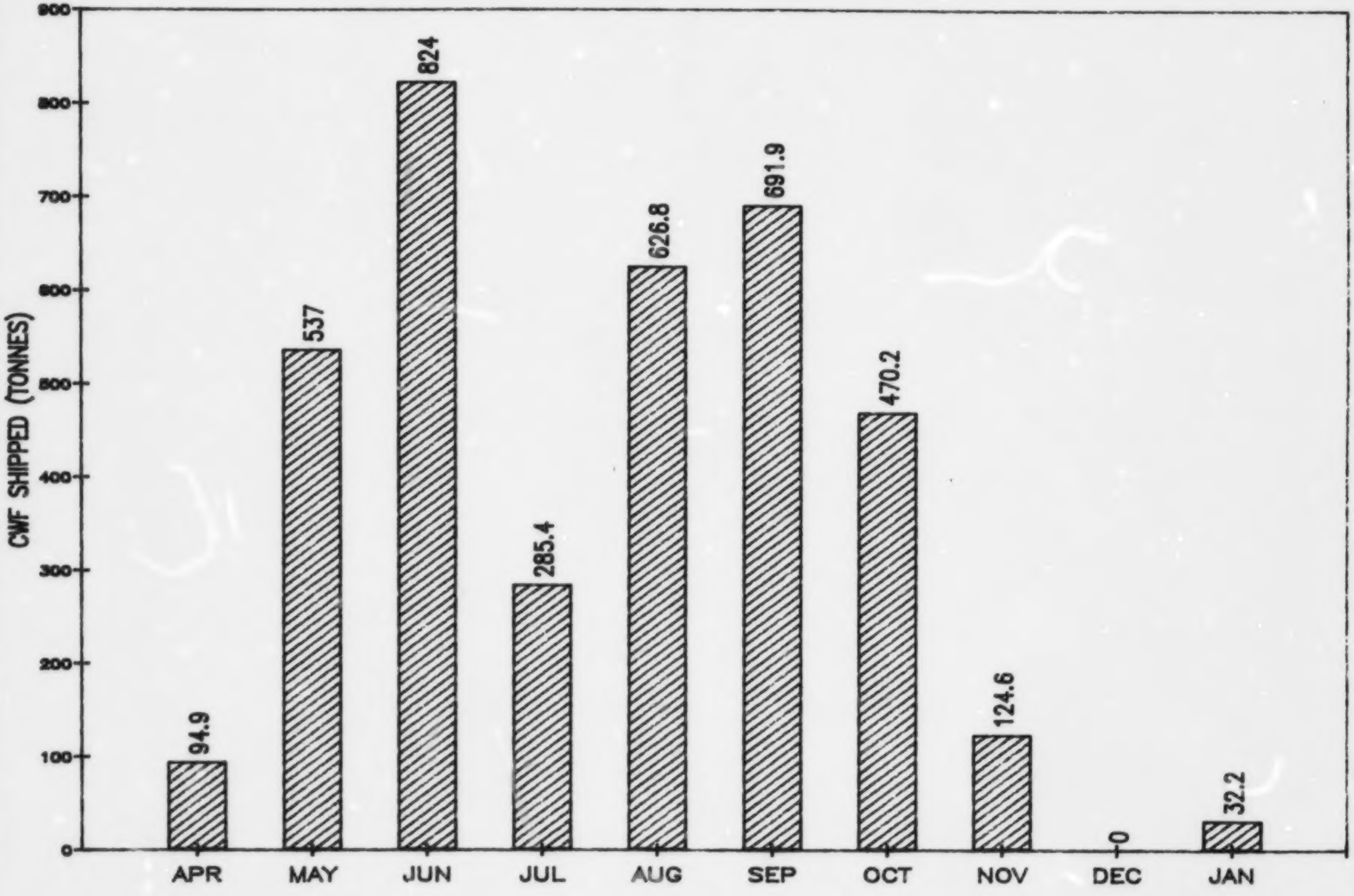
Month	CWF Hours	HFO Hours	% CWF
April	0	0	
May	163	65	71
June	345	3	99
July	174	237	42
August	421	138	75
September	487	51	91
October	269	148	65
November	53	329	14
Total	1912	971	66

4.4 Project Costs

The estimated cost and the cost sharing for the project were previously given in Section 3.0. As the project progressed some deviations occurred. The total estimated for coal ($1,260,000) was high because far less CWF was burned than anticipated. The conversion itself incurred some overruns, and subsequent modifications and testing added to the overall costs. The cost of the project up to the time of this report is given in Table V-A. A breakdown of the conversion is included as Table V-B. Budget updates are also included in the Progress Reports attached as Appendix C.

The Engineering Overruns in Table V-A are mainly the cost of some of the modifications as well as other equipment which was installed after some operating time (new filter set, high shear mixer, ceramic components for atomizer). The MBP&P Extra Costs included training for operators, and E&I personnel, installation of a larger main steam header and MBP&P input into the various modifications. Both of these figures from Table V-A are estimates only.

FIGURE 6. MONTHLY CWF SHIPMENTS TO MBP&P



TOTAL CWF SHIPMENT=3687 TONNES

TABLE IV-A - COSTS FOR THE MBP&P CWF CONVERSION PROJECT

DESCRIPTION	CONTRIBUTORS				
	CBDC	MBP&P	OSF	CANMET	TOTAL
Conversion Costs	113,000	295,304	467,900	300,000	1,176,204
Engineering Overruns	100,000				100,000
MBP&P Extra Costs		454,696			454,696
Flyash Characterization			40,265		40,265
Emissions Testing	25,000				25,000
Boiler Controls Modifications			29,057		29,057
CBDC Net CWF Cost	606,089				606,089
Total	844,089	750,000	537,222	300,000	2,431,311

TABLE IV-B - CONVERSION COSTS FOR THE BOILER

	Original Budget	Revised Budget	Actual Cost	Variance
Civil Site Preparation	92,500	121,188	223,418	(102,230)
Boiler (Purchase, Transport, Installation)	188,000	275,203	405,768	(130,565)
Fuel Handling System	78,000	81,060	52,985	28,075
CWF Burner	164,200	299,065	294,155	4,910
Electrical Instrumentation	188,000	196,744	196,744	
Bonding, Permits, Certificates	0	3,134	3,134	
Project Contingency	68,900	28,000	0	28,000
Total	779,600	1,004,394	1,176,204	(171,810)

5.0 - Technical Discussion

Subsequent to completion of commissioning, the project moved into a phase of long term activities focused on continuous operation on CWF and optimized performance. Concurrent with routine data acquisition, three major modifications to the burner were implemented, several tests were conducted and a study of particulate cleanup costs was initiated.

Each of these events are discussed in the following sections under their own respective headings.

5.1 Data Acquisition

Two methods of data acquisition were employed, and were designed to complement each other. An IBM-AT connected to a plant loop recorded process data automatically at one minute intervals and stored information in hourly and daily logs. The boiler operators also recorded operating data manually using operator log sheets. This data has been reduced and included in Appendix I.

5.2 Tertiary Air Ports

Shortly after commissioning had been completed, difficulty in maintaining a stable CWF flame was encountered, especially as attempts were made to increase load. High windbox pressure (10 inches W.C.) indicated that most likely the instability was caused by excessive combustion air velocities at the burner exit. At an impromptu meeting of the Technical Sub-Committee on May 5/88, the decision was taken to drill a series of 4-inch holes, surrounding the burner, through the front wall of the boiler. This relieved the high windbox pressure, permitted tertiary air to enter the furnace, reduced burner air velocity and significantly improved flame stability. In total, eight 4-inch holes were drilled (see photo H-16, Appendix H) and eight 4-inch threaded nipples were installed in the event capping was necessary, which it was not for CWF firing. As a result, boiler capacity on CWF was extended to the 35,000 to 40,000 lb./hr. steam range with good stable firing conditions.

5.3 Primary Air Can Enlargement

An analysis of combustion aerodynamics and tertiary port firing led to a decision by the Technical Sub-Committee on May 30/88 to install an expanded metal screen in the windbox and a 14½ inch primary air can and swirler. The screen would be positioned to break up suspected windbox stagnation air flow patterns and the 14½ inch can would replace the existing 13½ inch can allowing more primary air and stronger recirculation. The result should have been increased stability and operating range.

There was no immediate difference noticed in performance, but after several days flame stability began deteriorating. Eventually the CWF flame failed within an hour of ignition. Attempts to correct this condition were not successful, so the screen and 14½ inch can were removed and the burning restored to its original condition before these last modifications had been made. Immediately, the boiler demonstrated the stable performance of before. (See Technical Sub-Committee minutes for August 15-16/88, Appendix F.)

5.4 Tertiary Damper Air Control

In the August 15-16/88 meeting of the Technical Sub-Committee, the decision was taken to modify the burner to enable increased sustainable boiler capacity above 40,000 lb./hr. of steam. Previously demonstrated sustainable boiler loads ranged from 35 to 40,000 lb./hr. but the unit is designed for 60,000 lb./hr.

A Tertiary air annulus, vanes and damper control were added to the burner in October, 1988 such that the tertiary air could be introduced to the furnace through the burner quarl, at the root of the flame. Adjustable vanes would enable co-swirl matching the secondary combustion air swirl and the damper would permit tertiary air ratioing. In the worst case, if this configuration did not work, the tertiary damper could be closed and the burner should revert to operating as it had before these modifications were implemented.

The results did enable a higher boiler capacity measured at 51,000 lb./hr. of steam, with the tertiary damper open and tertiary vanes set to impart a low degree of swirl. However, below 30,000 lb./hr. of steam, the tertiary damper had to be closed to maintain stable firing conditions. It was also observed that the minimum steaming rate obtainable under unsupported combustion conditions was 20,000 lb./hr. of steam compared to about 18,000 lb./hr. previous to the modification. Some sacrifice of low end firing capability had thus been made for an increase in top end. Also the tertiary air ports must remain open at all times on CWF. Stable CWF firing could not be obtained when they were capped with the tertiary damper open.

It should be noted that the upper limit of 51,000 lb./hr. steam was not a function of boiler capacity but rather of plant demand. A valved tee has since been installed in the main header to enable the addition of steam venting equipment but further work was prohibited due to lack of funds.

5.5 CWF Flyash Characterization

In September, 1988 the Nova Scotia Research Foundation Corp. of Dartmouth, N.S. performed on-site particulate capture in a program supported by the Oil Substitution Fund designed to characterize CWF flyash. This characterization was an essential first step in estimating the cost of a flue gas particulate clean-up system for installation at the Minas site.

A description of the test work and report on the results is included as Appendix J. A copy of an internal report completed by EMR on this work is also included in Appendix K.

5.6 Emissions Testing

Energy, Mines & Resources CANMET personnel conducted gas emissions tests during July, 1988 under several different sustained combustion conditions. Particulate emissions rate was measured at the same time and typical gas and particulate results are presented in the Table V. Data from all tests run is included in Appendix L.

Table IV: EMR Emissions Test Results - Typical

Component	Measured 1) CWF	Value 2) Oil
Oxygen (% Vol.)	5.0	4.5
Carbon Dioxide (% Vol.)	12.8	13.5
Carbon Monoxide (ppm)	10.0	10.0
NO_x (ppm)	270.0	170.0
SO_x (ppm)	889.0	1270.0
Particulate Concentration (g/sm^3)	3.5	0.1

The emissions rate as determined during the NSRF fly-ash characterization test verified the EMR findings of July.

A subsequent emissions test in November by Ortech International and sponsored by CBDC tested the boiler under higher excess oxygen conditions and after the teritary air damper had been installed. The particulate rate was higher, partly due to a higher ash content in the fuel fired in November compared to July and September.

In general the findings indicate that particulate emissions from the CWF boiler are typically in the range of 4 $g/std.m^3$.

Gas analysis data obtained during the Ortech International testing program revealed some interesting results with respect to NO_x emissions. At the conclusion of the specified test program, with gas analysis equipment still on line, the boiler was set to a low excess air level, and flue gas composition recorded with the tertiary damper open and the tertiary damper closed. NO_x emissions were observed to be lower with the tertiary damper closed. This setting forced more combustion air through the tertiary ports located further out from the burner center and resulted in a greater reduction in NO_x. See the graphs of Appendix M.

5.7 Particulate Clean-up

Based on the results determined by NSRF in the flyash characterization study and on-site specific factors determined through discussion with Minas Basin Pulp & Power Engineering personnel, CBDC called for quotations on a particulate removal and storage system which would bring stack particulate emissions within provincial DOE guidelines of 250 mg/std.m^3. The cost estimate for a system which could provide at least 96% collection efficiency was $350,000 Cdn. There are no commercially available cyclone systems capable of this level of efficiency (maximum 80%), hence a baghouse was recommended (98-99% efficiency typical). Disposal would be dry to municipal landfill.

However, with financial contribution to the project by Minas Basin Pulp & Power already above the estimated cost of an equivalent oil boiler installation, and budgetary restrictions implemented by CBDC, the funds to cover capital cost of a particulate removal system could not be found in spite of an offer from the Oil Substitution Fund Committee to contribute up to $100,000 on a matching dollar basis. Plans to proceed with installation of a particulate removal system for this demonstration project were thus abandoned.

5.8 Boiler Inspections

Several inspections of the furnace interior were conducted during the course of the project.

Apr. 11/88 - Initial inspection after two weeks of cycling temperatures during commissioning on oil.

The only sign of deterioration was the appearance of a gap between the new refractory of the burner throat and the old refractory of the boiler front wall. When installing the CANMET burner, only enough of the old front wall refractory was removed to make room for the new refractory throat configuration.

The opening of this gap was not unexpected as combustion heat caused the new refractory to shrink initially. The gap was filled by packing high temperature Kawool insulation in the space.

May 30/88 Second furnace inspection after 350 hours operation on CWF and combustion of 600 tonnes of slurry (see photo H-13 to H-16, Appendix H).

Ash accumulations were not considered severe either in the furnace or generating tube bank. Most ash retrieved from these areas was light brown in color and appeared to contain virtually no carbon. A thin (1/2" to 3/4") layer of slag covered the furnace floor for the first ten feet beyond which a crusty, easily broken material appeared, giving way to the light brown ash about 6 inches in depth at the rear wall. Ash caught at the boiler exit may have been trapped by a slightly protruding lip in the ductwork at that point. There were no signs of erosion.

The refractory quarl showed signs of both impingement of coal particles and oxidation. In particular, a circular concave depression in the refractory was observed. It measured 7 - 8 inches deep, 8 to 10 inches across and was located at about the 2:00 position in the quarl. Slag (1/2 - 3/4 inches thick) coated the front wall of the boiler below the burner throat extending down to the floor.

Samples of ash were taken from various places in the boiler. The second inner row of screen tubes were observed to have acquired a growth of ash whiskers, easily removed and again, pictures and samples were taken.

It was decided that floor slag would remain but the lighter and more easily removed ash could be removed. One bbl. of material was removed.

July 4/88 - Third furnace inspection after an additional 825t of CWF had been consumed representing approximately 600 hr. of operation (see photos H-17 to H-20, Appendix H). Total CWF to date = 1450 t. Hours of operation on CWF to date = 950 hr.

Ash accumulations at the rear of the furnace measured about 1 foot deep at the rear wall. A tall layer of light, fluffy reddish colored ash lay on top of the highest tube along the rear wall. Sidewalls were fairly clear with only a light coating between the tubes beginning halfway back and occurring from there to the rear wall. Screen tubes revealed ash whisker deposits as before. Mud drum was under 4 - 8" of light, dusty, reddish colored ash.

The burner throat buildup was more extensive than on the previous inspection - about 1 inch thick near outer edge of quarl and tapering to nothing near the primary swirler. A large buildup has accumulated on the front wall extending from the floor to above the lower 4 in. tertiary air port. The air hole itself remained clear. Adhered material was brittle and difficult to separate from the refractory. 3 to 4 barrels of ash were removed from the furnace.

Oct. 11/88 - Fourth furnace inspection after an additional 1825T CWF had been consumed representing approximately 1200 hours of operation (see photos H-21 to H-24, Appendix H). Total CWF fired to date = 3275t. Total hours of operation on CWF to date = approximately 2150 hr.

Slag/ash accumulations blocked the manway entrance to the furnace through the front wall. Access to the furnace was only possible through a newly installed door at the rear of the furnace. Ash accumulation at the back of the boiler was about 1½ ft. at the rear wall with a crusted surface over a layer of dusty red ash. The lower left hand corner of the screen tube opening was blocked with deposits an area of about 2 sq. ft. This deposit material was not fused but had more of a caked nature and was easily knocked off and could be crumbled with minimal effort. The mud drum was covered with about 1 foot of light, dusty ash,

6.0 Conclusions

The Minas Basin Pulp & Power CWF Conversion provided an excellent opportunity to apply a relatively new fuel production/combustion technology to an industrial user. There were a number of favorable conditions for this project:

1) A series of demonstration projects over the past several years had resulted in a general refining of the CWF technology;

2) An excellent core covering all aspects of the technology existed in Eastern Canada (Ottawa and east), and complete involvement was committed to this program;

3) Supporting programs were available to help finance the conversion.

There were also some factors that worked against the project:

1) Continuing low world oil prices adversely affected the overall economics of the fuel supply;

2) In spite of the general willingness by MBP&P as an industrial user of CWF, the physical location of their plant in a residential environment constrained the program objectives for CWF burning;

3) The inability of the program to provide a particulate cleanup system resulted in limited CWF firing capability.

The overall project can best be considered a valuable learning experience. The various successes were intermixed with some disappointments. Some risks were taken, some inroads were made and some lessons were learned. A general assessment of the project is given here.

6.1 CWF Production and Handling

The MBP&P CWF Conversion Project used about 3700 tonnes of CWF. This fuel was produced over an eight month period. Fuel was delivered to MBP&P from inventory at the CWF Plant by 32-tonne road tanker, and stored in two 75-tonne tanks located within the #7 boilerhouse. The listing and analysis of all CWF deliveries to MBP&P are given in Appendix N.

The CWF production was routine, although in the latter stages the ash content increased. Storage at the CWF Plant and transpsortation by road tanker posed no problems. Storage at the MBP&P site, however, did indicate two related problems.

The first problem was drying of the CWF on the surface, within the storage tank. This was caused by the particular conditions of the tanks location. They were next to the boiler and initially the boilerhouse was not ventilated. This resulted in very hot temperatures and the drying of the CWF. The dried layer, if broken (eg. offloading new fuel on top of it) could settle and either remain in the bottom or, if it got into the fuel line, cause problems downstream.

The second problem was also a result of the hot environment of the boilerhouse. If the CWF was stored for an extended period of time, say more than 6 weeks, severe settling occurred. This settling took place due to heat affects on the chemical stabilizer itself, as bacterial growth was not present in all samples. Even blending in fresh stabilizer on site at MBP&P did not result in stable CWF; this same CWF, when brought back to the CWF plant, was easily returned to a stable state with adequate chemical treatment and mixing.

Although it should not be necessary to have complete CWF treatment capability at the user's site, it would be beneficial to have some facilities for dealing with unstable fuel conditions. The basic requirements would be mild agitation and recirculation. Agitation by air lancing was done at MBP&P in the case of very unstable fuel, but its affect was confined to the area of the air lance itself. A mechanical agitator would be preferable; perhaps a submersible type which could be moved, would be the best. Recirculation of CWF should be built into the CWF piping system from the first to avoid having to add this capability at the time of need.

The temperature of the storage area, and perhaps to a lesser degree the exposed surface area, were highlighted at MBP&P. Although the general effects of temperature on CWF were known, no real experience existed. The conclusion from the MBP&P project was that long-term storage (6+ weeks) at high ambient temperature (+30°C) destroy/ weakens the chemical stabilizer (at least the particular stabilizer used for this CWF). It is, therefore, recommended that CWF storage temperatures be limited to less than 25°C, or that the time of storage be limited to less than 1 month at the user site. The use of a floating cover or collapsible liner to avoid any exposed surface should be a consideration in any subsequent storage applications.

6.2 Boiler Conversion and Operation

The boiler conversion for MBP&P must generally be considered as successful. A number of design changes were made initially, including enlarging the windbox, adding an air pre-heater and changing the burner. Some changes were made as the project was ongoing, such as the addition of the tertiary air ports, the air register modifications and access doors for ash cleanout. The addition of particulate collection was considered, but not acted upon.

During operation, the expected firing range was not satisfactorily achieved. It was hoped that the boiler would operate between 15,000 and 65,000 lb./hr. of steam (14.5 - 63 MMBtu/hr.).

The steam requirements at MBP&P were not consistently high enough to adequately determine the top end. Plans were made during the October shutdown to install a Tee in the steam line to allow full-load firing in the #7 boiler and vent off excess steam. However, there was not sufficient funds to purchase and install a condenser as required for this modification.

As for the low end of the range, problems in flame stability occurred at reduced firing rate because of the subsequent drop in windbox (combustion air) temperature. This could only be corrected with some form of auxilliary air heating, which would not be very efficient. Multi-burner arrangements have been suggested for CWF conversions where a broad operating range is expected. In this case, however, the windbox temperature could still be the limiting factor as it was in the particulr case of the #7 boiler at MBP&P.

Another aspect of the conversion which later required some modification was the boiler control logic. It is obvious that this must be done with complete consideration given to the particular operating requirements of the user.

Many of the decisions made in the design of the boiler conversion reflected both fiscal considerations and inexperience. Each conversion must be considered independently, and although it was realized that the MBP&P conversion was unique, the lack of experience with this type of boiler, at the scale of operation, and perhaps even the overall conditions of operation, led to the need to make some modifications. The nature of CWF as a coal-based fuel must not be underestimated; this requires special consideration for ash removal/handling, and should be a key factor in conversions.

6.3 Burner/Atomizer Performance

From experience at MBP&P, it can be concluded that burner design and atomizer wear life are not perfected. The "burner" underwent at least three modifications (see Sections 5.2, 5.3 and 5.4), and others were considered. Several ceramic materials were used and some "eccentricity" was noted in the gap; atomizer wear life was at best several hundred hours. Documentation in the atomizer material is given in Appendix O.

It is not the intent of this report to analyze the air register and atomizer. However, these items should have a minimum of adjustments associated with their operation/ performance. The adjustability of the air register and atomizer probably caused more upsets than improvements. In fact, in the end the "dual-fuel" atomizer was changed each time that the fuel source (HFO or CWF) was changed, rather than adjusting the atomizer configuration.

It can be concluded that the burner and atomizer used at MBP&P are not fully developed for that particular application. Although they represented state-of-the-art development in Canada, they fell short of meeting the desired performance.

6.4 Overall Economics

In the final analysis, it was economic considerations which led to the termination of CWF firing at MBP&P. In spite of the funding support provided and the committments by people to resolve any technical difficulties, the low world oil price made continuation of supply of CWF unfavorable.

For a project of this nature to succeed there must be a price differential between HFO and CWF sufficient to allow the user to see a financial benefit and the supplier to cover production costs. Delivery of the CWF represented a substantial element of the overall CWF cost, and this can only be overcome when shipment can be made in large quantities.

CWF production has become routine in the CBDC CWF Plant. However, no major reductions in the production costs have been achieved. Marketability of CWF, therefore, depends on world oil prices rising substantially.

Government of Canada
Gouvernement du Canada

Cape Breton Development Corporation
Société de développement du Cap-Breton

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CONTRACTOR: CAPE BRETON DEVELOPMENT CORP.

COAL WATER FUEL CONVERSION OF AN INDUSTRIAL OIL-DESIGNED PACKAGE BOILER IN A PULP AND PAPER PLANT, HANTSPORT, N.S.

APPENDIX A-D

256 pp + FIGURES

APPENDIX A

ORIGINAL CBDC PROPOSAL TO CANMET

CAPE BRETON DEVELOPMENT CORPORATION

PROPOSAL FOR THE COAL-WATER FUEL CONVERSION OF AN INDUSTRIAL OIL-FIRED PACKAGE BOILER IN A PULP AND PAPER PLANT, HANTSPORT, NOVA SCOTIA

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Submitted to

Canada Centre for Mineral & Energy Technology
Research Program Office

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SUMMARY

This proposal describes the Cape Breton Development Corporation's plan to conduct a long term demonstration of the use of coal-water fuel (CWF) to fire an oil-designed industrial package boiler and supply 100% of plant steam requirements on a continuous basis.

The principal purpose of the project is to clearly demonstrate the technical and economic viability of using CWF as an alternative to imported heavy fuel oil.

The site of the project is the Minas Basin Pulp and Power (MBP&P) plant located at Hantsport, N.S. The demonstration will consist of installing a used 60,000 lb./hr. oil-designed package boiler at the plant (including ancilliary equipment), tying-in to existing steam lines, converting the boiler to burn CWF, commissioning of all equipment and monitoring and evaluating system performance over a period of up to two years.

This proposal describes: the scope of work proposed; a management plan which includes monitoring, control and reporting methods; and an estimate of project cost with a proposal for cost sharing. A description of deliverable items as well as factors which illustrate the scientific merit, uniqueness and benefits of the project are also included.

It is considered that this proposed demonstration entails significant technical and financial risk to the Cape Breton Development Corporation. The success of the project, however, will generate substantial benefits to MBP&P, CBDC, the Canadian Government and industries throughout Canada with similar applications for the use of CWF as a substitute for heavy fuel oil. This demonstration will represent the first major transfer of CWF technology into the industrial pulp and paper sector.

The total cost of the demonstration program is estimated at $2,130,900.00.

CONTENTS

Page

SUMMARY

1. INTRODUCTION 1

2. INDUSTRIAL LOCATION 4

3. TECHNICAL PROPOSAL 5
   - 3.1 Conversion to CWF 5
     - 3.1.1 Engineering Activities 5
     - 3.1.2 Contracted Activities 6
     - 3.1.3 Commissioning and Startup Activities 7
   - 3.2 Long Term Operation on CWF 8
     - 3.2.1 Fuel Supply and Delivery 8
     - 3.2.2 Data Acquisition System 9
     - 3.2.3 Performance Monitoring 9
     - 3.2.4 Evaluation and Reporting 10

4. MANAGEMENT PLAN 12
   - 4.1 Cape Breton Development Corporation 12
   - 4.2 Minas Basin Pulp & Power 15
   - 4.3 Project Management Structure 17
   - 4.4 Project Monitoring and Control 19
     - 4.4.1 Cost Control 19
     - 4.4.2 Schedule control 20
     - 4.4.3 Technical Performance Control 20
     - 4.4.4 Performance Evaluation 21

5. SCHEDULE 22

6. COST ESTIMATE 25

7. COST SHARING PROPOSAL 26

8. DELIVERABLE ITEMS 28

9. SCIENTIFIC MERIT, UNIQUENESS AND BENEFITS 29
   - 9.1 Scientific Merit 29
   - 9.2 Uniqueness 29
   - 9.3 Benefits 30

APPENDIX 1 - CARBOFUEL PRODUCTION PROCESS 31

APPENDIX II - PROJECT PERSONNEL 40

APPENDIX III - DETAILED CONVERSION COST ESTIMATE 48

LIST OF FIGURES

		Page
Figure 4.1:	CBDC Corporate Structure	13
Figure 4.2:	MBP&P Organizational Structure	16
Figure 4.3:	Project Management Structure	18
Figure 5:1:	Project Schedule	23
Figure A-1:	Carbofuel Process Diagram	32
Figure A-2:	Carbofuel Production Plant Management Structure	36
Figure A-3:	Detailed Conversion Cost Estimate	48

LIST OF TABLES

		Page
Table 6.1:	Project Cost Breakdown	25
Table 7.1:	Proposed Cost Sharing Scheme	27

1. Introduction

In 1982 the Cape Breton Development Corporation (CBDC) acquired exclusive Eastern Canadian manufacturing rights to Carbogel technology. Eastern Canada, because of its dependence on imported oil and its proven coal reserves, was considered a good location for large scale manufacture of coal-water fuel (CWF) as a replacement for heavy fuel oil (HFO).

To introduce this new energy source, CBDC constructed a 4 tph continuous production coal-water fuel plant at Victoria Junction, beside the corporation's coal preparation plant near Sydney, N.S. The CWF plant began operation in 1983 and was recently upgraded through a $2.6 million expansion to 7 tph. To date over 14,000 tonnes of fuel have been produced at the plant and burned in utility boilers, industrial furnaces and experimental test rigs.

Two major test projects utilizing Carbogel CWF, or Carbofuel as it is now becoming known, have demonstrated the potential of Carbofuel as an alternate fuel. 6000 tonnes were produced between 1983 and 1986 for use in a burner development program conducted at the Chatham Generating Station of NBEPC. 2800 tonnes were supplied in 1985 to Iron Ore Canada, Labrador City, in a project which demonstrated the conversion from oil to CWF of a 200 tph pelletizing induration furnace. It was successfully operated on a continuous basis for 30 days.

A 15,000 tonne demonstration in a 20 MW_e utility boiler at Charlottetown, P.E.I. is presently in the shakedown stages. This will provide an opportunity to evaluate oil-designed utility boiler performance on CWF.

Coal-water fuel is the most advanced high-tech method of coal utilization in existence today. It is also the most promising and CBDC is a recognized world leader in the development of the technology. The successful production and testing of Carbofuel have resulted in the corporation's ability to produce a high quality fuel that can compete directly with oil for utility, industrial and, eventually, domestic use.

With millions of dollars of government support already invested in bringing CWF technology this close to commercialization in Canada, it is only appropriate that the next step now be taken: a continuous long term demonstration of industrial or utility use of coal-water fuel. This accomplishes at least two things. It keeps the technology alive and improving and it provides an example for other industries to follow. Marketing research recently completed by CBDC reveals the potential in Atlantic Canada for coal-water fuel to displace 43% (4.5 million bbls.) of the foreign oil now consumed in the Atlantic Provinces. Of the 4.5 million, 1.4 million bbls. can be displaced in the pulp and paper industry alone.

The potential thus exists for the sale of 900,000 tonnes of coal per year in Atlantic Canada in the form of Carbofuel CWF. But someone has to be first to convert. Through the efforts of the Cape Breton Development Corporation, a pulp and paper industry in Nova Scotia has developed a strong interest in converting to coal-water fuel with the potential of displacing in excess of 60,000 bbls. of heavy fuel oil per year.

Plant conversion to CWF will address the following and as yet unanswered questions:

1) Can an oil-designed package boiler be operated effectively and economically using coal-water fuel over an extended period of time?

2) What will the performance characteristics (eg. wear, efficiency, turndown, load following capabilities and maintenance requirements) of the selected CWF burner prove to be under long term operating conditions?

3) Compared to a heavy fuel oil handling system, will a CWF delivery system be more, less or equally as cost effective operating on a continuous basis?

This proposal presents a plan to obtain answers to these questions through the installation and conversion to CWF of an oil-fired package boiler and the monitoring of system performance over a two year period. In particular, it proposes financial assistance from Canmet with the capital cost of the conversion project as well as advisory assistance in CWF combustion technology.

2. INDUSTRIAL LOCATION

Located in Hantsport, Nova Scotia, on the shores of the Minas Basin approximately 75 Km. from Halifax, is the Minas Basin Pulp and Power Company Limited (MBP&P). In addition to supplying pulp as feedstock for the neighboring Canadian Keyes Fibre (CKF) plant, where a variety of molded paper products are produced, MBP&P operates a paper mill with an average daily production of 100 tons of linerboard material. Process steam requirements for both CKF and MBP&P are supplied from a six-boiler steam plant owned and operated by Minas Basin Pulp and Power. The boilers, two of which are wood fired, are all of a package type and range in age from 40 to 19 years. Average steam load is in the range of 30 - 40,000 lb./hr. on a continuous basis.

In September, 1986, Minas Basin Pulp and Power were approached by CBDC and introduced to the possibility of displacing their heavy fuel oil requirements with Carbofuel CWF.

3. TECHNICAL PROPOSAL

A program has been developed to acquire a used 60,000 lb./hr. package boiler available from the AECL Heavy Water Plant in Glace Bay, N.S., install it at the MBP&P plant and convert it to burn CWF for a minimum two year period. The boiler will tie in to existing plant steam lines and supply 100% of MBP&P's steam requirements on a continuous basis. This will enable conversion to CWF with minimal interruption to the steam supply - a critical prerequisite since the plant supplies process steam requirements for two industries.

Fuel delivery to the plant will be on a daily basis by road tanker from the Carbofuel plant at Victoria Junction. Fifty tonnes of CWF per day will be required to fuel the plant's steaming requirements.

The complete project is divided into two phases: (A) conversion to CWF and; (B) Long term operation on CWF.

3.1 Conversion to CWF

By far the largest element of this long term plan is the conversion of the plant to CWF. The scope of the conversion phase is presented under three main headings: Engineering Activities; Contracted Activities; and Start-up and Commissioning Activities.

3.1.1 Engineering Activities

1) Familiarization with the AECL boiler, equipment, controls and P&I drawings will be necessary. This will require site visits to procure drawings, inspect usable equipment and to transport certain items to the Carbofuel plant for testing (motors, pumps, etc.).

2) Site visits to Minas Basin Pulp and Power will be required to identify boiler location and develop plans for controls and tie-ins. Relevant steam plant drawings will be obtained and the fuel supply tankage location determined.

3) Burner selection and CWF conversion requirements for the boiler must be addressed. With support from the coal-water fuel combustion experience and expertise of Canmet, boiler conversion specifications and drawings will be developed.

4) Engineering drawings will be made for process and instrumentation, boiler layout, fuel handling system, boiler modifications, ancilliary equipment and a data acquisition system.

5) All equipment and materials required for the conversion to CWF will be specified and costed. A preliminary budget estimate has been prepared and is presented in Appendix III.

6) A plan will be developed for boiler commissioning on both oil and coal-water fuel. Operator training will also be included to ensure that proper operating procedures are followed.

3.1.2 Contracted Activities

1) Civil site inspection at MBP&P, design of foundations and enclosures and cost estimates will be necessary.

2) Site preparation will include old (1947) #3 boiler removal and the construction of necessary foundations and enclosures.

3) The new boiler and any ancilliary equipment will be removed from the AECL plant in Glace Bay and transported to Hantsport where it will be placed on site ready for installation.

4) Installation of the boiler will include: tie-ins to existing steam, water and electrical lines; connecting of all ductwork, air heater equipment and stack; installation of both FD and ID fans and; installation of boiler controls, burner management system and data acquisition equipment.

5) Installation of the fuel storage and delivery system will include tanks, offloading pump, fuel delivery pump, lines, valves, fittings and controls.

6) Conversion of the boiler to burn CWF will require modification of the boiler front including new refractory and a new burner assembly. The present plan is to use a Canmet/NRC steam atomizing CWF burner, similar to the unit developed as a result of the Chatham, N.B. burner development work.

3.1.3 Start-up and Commissioning Activities

1) When all systems are in place, the previously developed commissioning plan will be executed. This will include any required inspections by the provincial Department of Labor and Safety, hydrostatic tests and the commissioning of all installed equipment, individually, before system start-up.

2) Upon successful commissioning of all equipment, the burner and ignitor will be commissioned first on oil then on CWF as the system undergoes start-up.

3) Operator training will take place during commissioning and start-up and will include both instruction and hands-on experience in safe operating procedures.

4) When all MBP&P personnel are trained in the operating procedures for the new equipment, and any problems encountered in start-up have been overcome, the plant will be turned over to Minas Basin Pulp & Power for continuous operation on CWF.

3.2 Long Term Operation on CWF

After plant turnover has occurred, it will be necessary to monitor the system for operating and performance characteristics. This section presents the scope of the long term operation phase under four main headings: Fuel Supply and Delivery; Data Acquisition System; Monitoring Program; and Evaluation and Reporting.

3.2.1 Fuel Supply and Delivery

1) The Carbofuel production plant has the capacity to produce in excess of 160 tonnes per day of CWF. The demand of 50 tpd for the Minas Basin Pulp & Power project represents approximately 1/3 of the plant output capacity. A description of the Carbofuel production process is given in Appendix I.

2) Fuel will be transported from the V.J. plant to Hantsport by road tanker. Approximately two truck loads (25 to 30 t. each) per day will be delivered to meet steam plant requirements.

3) On-site storage of fuel will be designed for a maximum capacity of 200 t. or a 4 day supply. An additional storage capacity exists at the Carbofuel plant of 1000 t.

4) Fuel will be off-loaded at MBP&P by means of either a self off-loader or an off-loading pump permanently located near the CWF storage tanks.

5) Excellent road access presently exists to the proposed storage tank area.

6) A fuel supply agreement to be signed between MBP&P and CBDC will be for a continuous supply of CWF for a 2 year period.

3.2.2 Data Acquisition System

1) A data acquisition system (DAS) will be developed and will be installed during boiler installation.

2) The DAS will be commissioned with the boiler and plant personnel will be familiarized with its operation.

3) Through use of a modem connection, any data acquired can be transmitted to the Carbofuel plant for reporting and troubleshooting.

3.2.3 Performance Monitoring

1) A program for monitoring and recording system performance during operation will be developed and implemented. This will enable the generation of

performance reports and will allow rapid identification of the cause of any operational problems by providing a historical record. Such a program could also be used to prevent equipment problems through its monitoring capabilities.

2) Viewports located at strategic points will provide visual access to the combustion chamber and the CWF flame and burner.

3) Visual observations of system and component performance will be made by MBP&P personnel on a regular basis. At least once per year during regularly scheduled maintenance downtimes the boiler will be entered and inspected for any detrimental effects of firing CWF on the burner or boiler components.

3.2.4 Evaluation and Reporting

1) Upon completion of plant turnover, and quarterly thereafter, a summary report will be prepared and issued. The report will contain a record of events to date, an evaluation of any relevant data monitored or observations made during the reporting period and a financial and economic analysis of project costs to date. Upon completion of the long term operation on CWF phase of the program, a comprehensive wrap-up report will be submitted to Canmet.

2) At any time after plant turnover, visitors with an industrial conversion interest will be welcome on site to view the operating system. In addition, all

parties contributing to the capital cost of the conversion will have access to any performance data acquired over the two-year period.

3) Several objectives have been identified for evaluation during the project and are listed as follows:

a) Analysis of any significant problems encountered during conversion and their solutions;
b) Evaluate the operational economics of an industrial CWF fired package-boiler system;
c) Evaluate the impact of continuous operation using CWF on boiler, burner and feed handling components;
d) Evaluate the capability of the boiler, burner and control systems on CWF, including turndown and load following ability;
e) Evaluate the environmental impact of operation on CWF.

4. MANAGEMENT PLAN

In presenting the management plan for this project, it is necessary to outline three organizational structures: the Cape Breton Development Corporation; Minas Basin Pulp and Power Ltd.; and the Project Management plan. The structure of the project management plan reveals how the CBDC and MBP&P organizational arrangements will interface to contribute to the overall management scheme for the project.

Methods for the monitoring and control of all elements of work are also presented in this section.

4.1 The Cape Breton Development Corporation

The Cape Breton Development Corporation is a federal crown corporation formed in 1967. Its mandate is the efficient exploitation of the Sydney coalfields and the related management of the large work force required to mine, process and market the coal. In its drive to develop new markets for coal, CBDC views the commercialization of coal-water fuel as an important element in its marketing strategy. This conversion project will move the corporation significantly closer to the commercial production of CWF.

Figure 4.1 presents an organizational chart of CBDC from the Board of Directors down through the Carbofuel Plant Manager, Mr. Bob Kazmel. The organizational structure of the Carbofuel plant below the manager is illustrated in Figure A-2, Appendix I. Management of the proposed project will be Mr. Kazmel's responsibility.

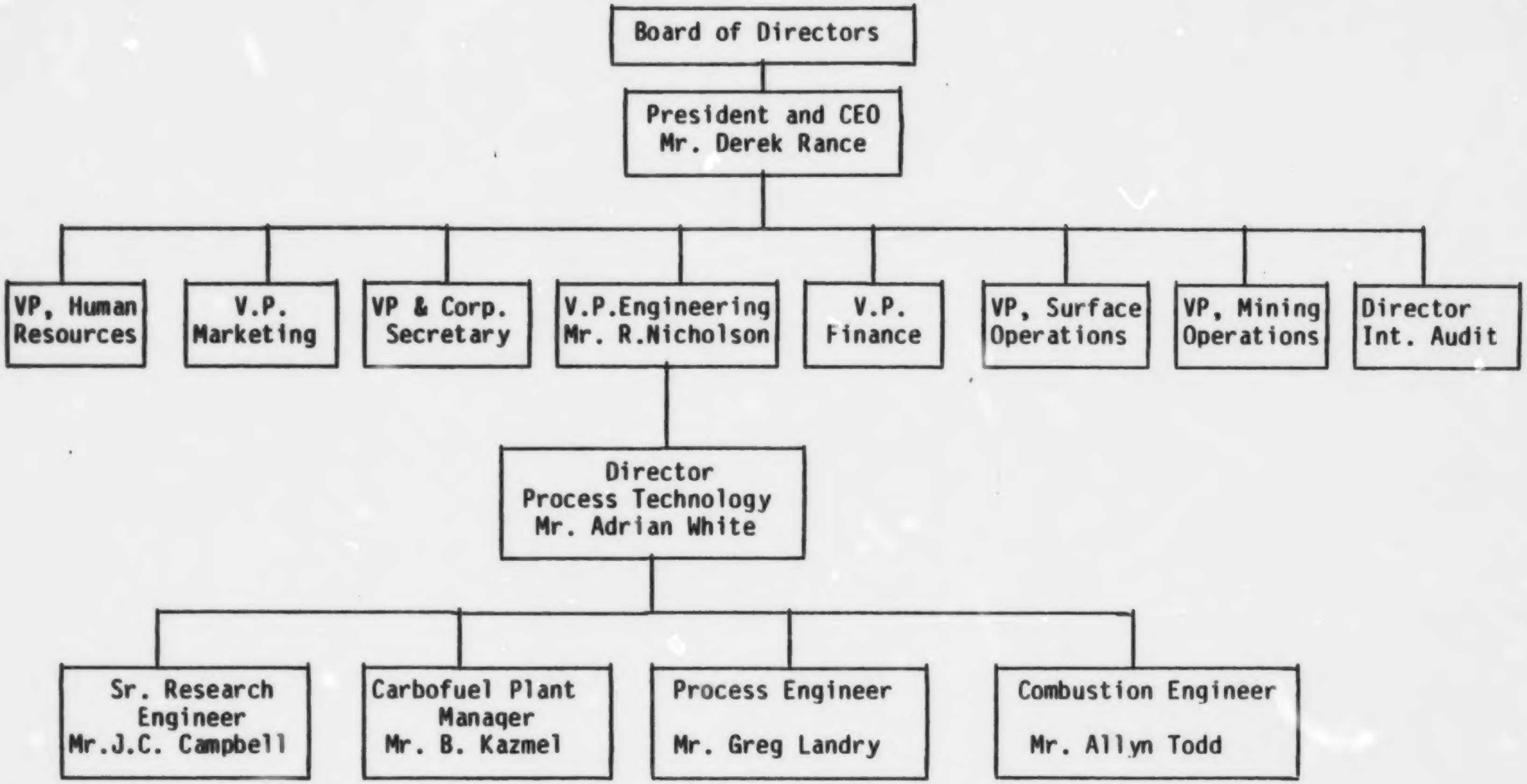

Board of Directors
President and CEO
Mr. Derek Rance
VP, Human Resources
V.P. Marketing
VP & Corp. Secretary
V.P.Engineering
Mr. R.Nicholson
V.P. Finance
VP, Surface Operations
VP, Mining Operations
Director Int. Audit
Director
Process Technology
Mr. Adrian White
Sr. Research Engineer
Mr.J.C. Campbell
Carbofuel Plant Manager
Mr. B. Kazmel
Process Engineer
Mr. Greg Landry
Combustion Engineer
Mr. Allyn Todd

Figure 4.1: CBDC Corporate Structure

CBDC brings a wide variety of relevant experience to this project, from the initial acquisition of a CWF technology to the supply of up to 15000 t of Carbofuel for the utility boiler demonstration currently under way in Charlottetown, P.E.I. The events which constitute this experience are summarized as follows:

1982 -	Acquisition of Carbogel CWF technology from Sweden.
1983 -	Construction and commissioning of 4 tph CWF plant at Victoria Junction, Cape Breton, N.S.
1983-85 -	Production of more than 6000 t CWF for the Chatham Generating Station of NBEPC (burner development program).
1985 -	Production of 2800 t CWF for Iron Ore Canada, Labrador City, and design and operating assistance with their CWF handling system.
1986 -	$2.6 million expansion of Carbofuel plant to 7 tph, ahead of schedule and within budget. Expansion project managed by Mr. Bob Kazmel.
1986-87 -	Production of up to 15000 t CWF for utility boiler demonstration, Charlottetown, P.E.I.

The well-rounded nature of the CBDC team that will carry out this project is reflected in its broad and experienced resource base of personnel. Resources include: plant and process engineering; quality assurance; instrumentation; control and data acquisition systems; CWF combustion systems design and performance evaluation; project management; and extensive CWF handling, delivery and storage experience.

4.2 Minas Basin Pulp and Power Co. Ltd.

In 1929, the Minas Basin Pulp and Power Company Ltd. began producing pulp for export to the U.S.A., at the rate of 5000 tons per year. By 1938 production had reached 20,000 tpy and over the next 40 years MBP&P divrsified its interests and investments to include association with or acquisition of companies engaged in lumbering, shipping, corrugated carton manufacturing, selling building supplies, developing real estate and food growing and processing.

A paperboard mill constructed in 1946 was producing 30,000 tons of paperboard per year by the mid-Seventies and Minas Basin has continued to be the largest industry and mainstay of the Hantsport economy since that time.

The organizational structure of the Minas Basin Pulp and Power Co. is shown in the chart of Figure 4.2. Scotia Investments Ltd. of Halifax, N.S. is now the holding company for a number of operational companies (including Minas Basin Pulp & Power) in an investment portfolio of the Scotia Investments Group which includes the original owners of MBP&P.

Mr. Aubrey Palmeter, P.Eng. of Scotia Investments Ltd. will act as Project Engineer for MBP&P and is assigned to this project in that capacity.

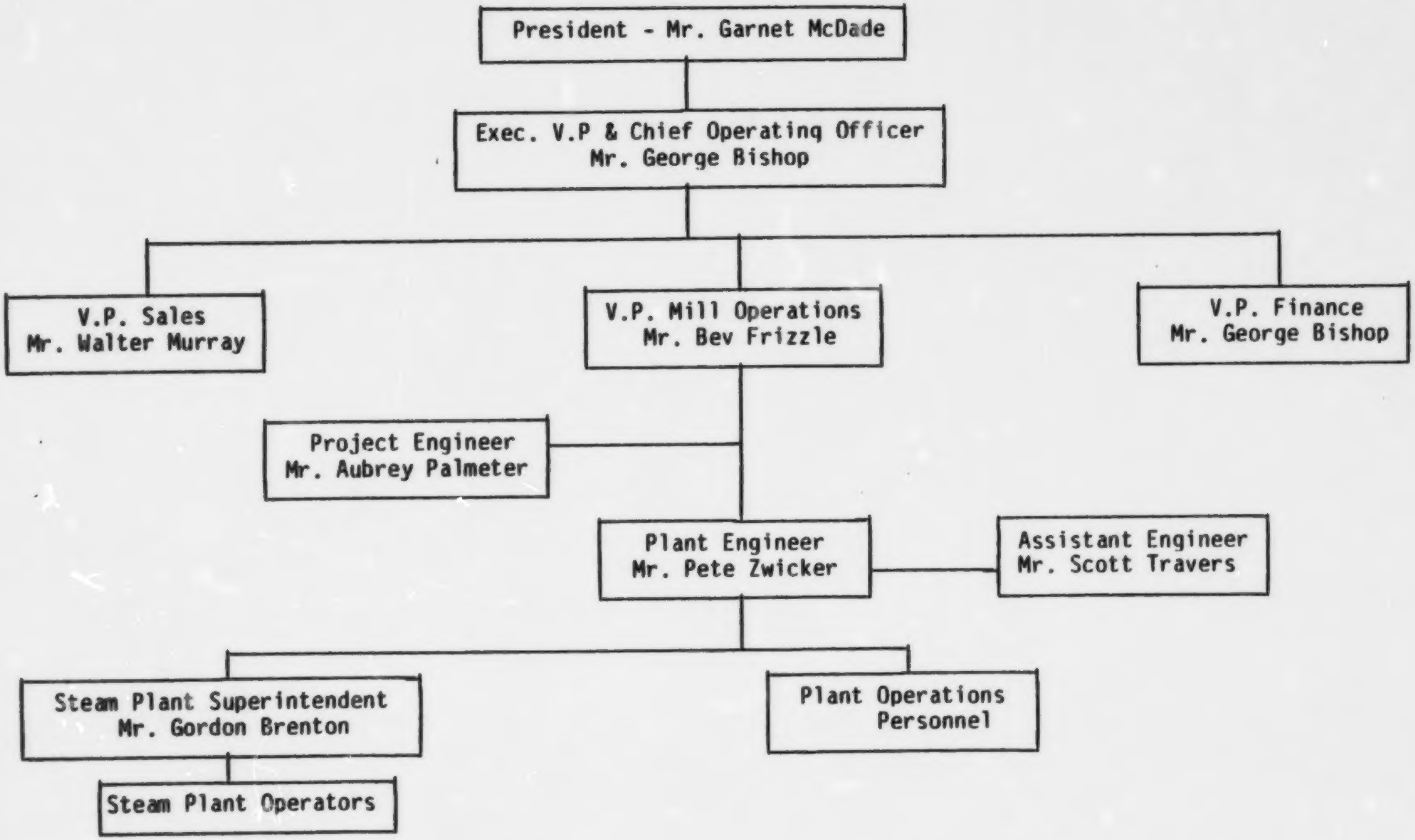

President - Mr. Garnet McDade
Exec. V.P & Chief Operating Officer
Mr. George Bishop
V.P. Sales
Mr. Walter Murray
V.P. Mill Operations
Mr. Bev Frizzle
V.P. Finance
Mr. George Bishop
Project Engineer
Mr. Aubrey Palmeter
Plant Engineer
Mr. Pete Zwicker
Assistant Engineer
Mr. Scott Travers
Steam Plant Superintendent
Mr. Gordon Brenton
Plant Operations
Personnel
Steam Plant Operators

Figure 4.2: MBP&P Organizational Structure

4.3 Project Management Structure

The diagram of Figure 4.3 presents in schematic form the manner in which the project will be organized. A steering committee will be formed consisting of one representative from each of the following groups: the Nova Scotia Dept. of Mines & Energy; Canmet; Minas Basin Pulp and Power; the Cape Breton Development Corporation; and a secretary from the Canada, Nova Scotia Oil Substitution Fund representing Energy, Mines and Resources Canada. The function of the steering committee will be threefold: to provide guidance where necessary in any significant changes to the scope of work during the project; to insure proper use of allocated funds; and to provide a vehicle for open discussion among members and periodic review of project progress.

Reporting to the steering committee will be the CBDC project manager. The responsibility for the management of the entire project is assigned to the project manager who has been designated as Mr. Bob Kazmel of CBDC.

Reporting to the project manager will be 3 key people: the MBP&P Project Engineer, Mr. Aubrey Palmeter, P.Eng.; a CBDC Project Engineer, Mr. Joel MacLean, P.Eng.; and a CBDC Contract Administrator, Mr. Greg Landry, P.Eng. A number of their respective major areas of responsibility are shown in the schematic of Figure 4.3. A very close relationship will exist between the MBP&P Project Engineer and the project manager, particularly in the planning stages. This will enable maximum input from MBP&P to proproject detail to ensure minimal disruption of plant operation during both the conversion and operational phases. Curriculum Vitaes of the four above named personnel are included as Appendix II.

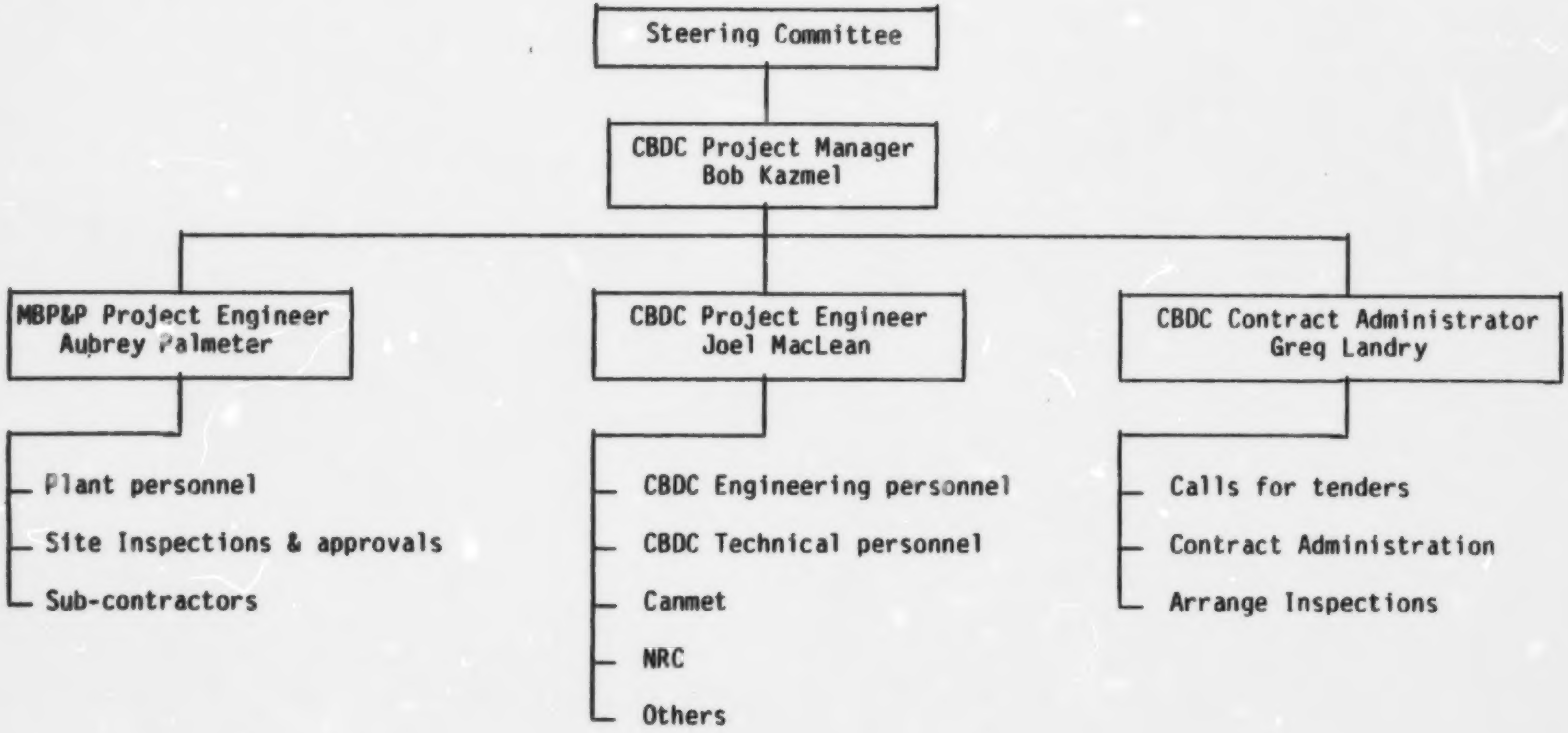

Steering Committee
CBDC Project Manager
Bob Kazmel
MBP&P Project Engineer
Aubrey Palmeter
CBDC Project Engineer
Joel MacLean
CBDC Contract Administrator
Greg Landry
Plant personnel
Site Inspections & approvals
Sub-contractors
CBDC Engineering personnel
CBDC Technical personnel
Canmet
NRC
Others
Calls for tenders
Contract Administration
Arrange Inspections

Figure 4.3: Project Management Structure

4.4 Project Monitoring and Control

The conversion phase monitoring and control methods will be applied in three main areas: cost; schedule; and technical performance. The long term operation on CWF phase monitoring will consist primarily of performance evaluation.

4.4.1 Cost Control

A budget estimate of project costs has been developed and a budget summary sheet is included as Figure A-3 in Appendix III of this proposal. The cost control system developed by CBDC has been computerized at the Carbofuel plant where updates can be entered routinely and printed out at any time. The budget summary sheet of Figure A-3 presents a budget status review in seven columns: 1) original budget; 2) revised budget; 3) variance; 4) actual; 5) sum of requisitioned amount; 6) sum of invoiced amount; and 7) estimate to complete.

The "Variance" is the difference between the original and revised budgets where the revised budget reflects a more accurate cost estimate based on tendered bids. The "actual" column is the dollar value of invoices paid and reflects the true cost to date of dollars actually spent. "Estimate to complete" is the difference between revised budget and invoiced amounts and will show the dollars remaining to complete the project.

Based on this cost summary tracking method a weekly budget review will be entered on the corporation's main frame computer for internal control purposes. The two systems together will act as a double cost control system.

4.4.2 Schedule Control

Using the computer sysem at the Carbofuel plant, a detailed project schedule has been developed. Major components of the schedule are presented in Section 5. Each event during the project is assigned a starting date and time frame for completion. Where possible this will be estimated from tendered bids and firmed up as bids are accepted. The planned schedule will be continuously compared to an actual schedule as work progresses with the generation of a weekly printed report for file. Any differences between planned and actual schedules will be fully documented including methods employed to minimize deviations from the planned schedule.

4.4.3 Technical Performance Control

To ensure that all tasks scheduled within the conversion phase of the project are carried out to acceptable standards, reviews, inspections and approvals will be implemented frequently at predetermined stages of progress. CBDC will be laying out specifications for all equipment required and will do the preliminary engineering, including drawings, in-house. Due to the requirements of insurance coverage on any engineering done for an area outside of CBDC's jurisdiction, such engineering work will require approval by an outside consultant and will thus be included as a part of the tender package. The boiler will receive a minimum of three inspections by the Nova Scotia Department of Labor: before the boiler is purchased, after the boiler is relocated and during commissioning prior to start-up. Geotechnical survey work will be completed by Minas Basin Pulp and Power prior to finalizing foundation designs. During construction and boiler installation, inspections of material, concrete and quality of work will be the responsibility of of MBP&P in conjunction with their insurance company. CBDC will be responsible for the commissioning of all installed systems and will ensure that all equipment operates according to specification. With the assistance of Canmet, CBDC will also commission the CWF burner and establish satisfactory performance parameters for the boiler on CWF.

4.4.4 Performance Evaluation

After plant turnover of the CWF boiler system to MBP&P for long term continuous operation, monitoring of system performance will begin. Any relevant performance measurements such as pressures, temperatures, flow rates and fluid levels will be automatically logged at specified intervals by the control system computer and stored on disc. This information will be retrievable both locally and at the Carbofuel plant via a modem connection. The raw data can then be reduced, evaluated and reported using both purchased and CBDC in-house developed software. Sufficient information will be available to determine boiler efficiency trends and operational economics. Visual inspection reports by boiler operators will routinely be submitted and occasional inspections on site by CBDC personnel will also assist in the evaluation of the specific objectives outlined in Section 3.2.4.

5. SCHEDULE

A chart showing the planned project schedule is given in Figure 5.1. Plant turnover to Minas Basin Pulp and Power is scheduled for September 30, 1987.

Cost estimations and funding negotiations have been on-going since November, 1986, and March 16, 1987, has been established as the target deadline by which all funding agreements will be in place.

The preliminary engineering also began in November, 1986 and will be completed on February 20, 1987, including the preparation of all tendering packages. The call for tender will go out on February 20, with all bids to be received no later than March 13. Tender will be awarded March 31, 1987.

The detailed engineering will extend from February 20 to July 31 on a non-continuous basis. Details will be addressed on an as-required basis.

Preparation of the site for landing the boiler will commence April 24. All major civil work will be completed by May 15 with minor elements, such as enclosure of boiler and equipment, scheduled to occur after the boiler and equipment are located on site.

Installation of the boiler and all related systems, materials and equipment is scheduled over a 3-1/2 month period from May 11 to August 31, 1987. During this time and after the boiler is located on site, conversion of the boiler front and installation of the CWF burner will take place, between June 1 and June 30.

1987

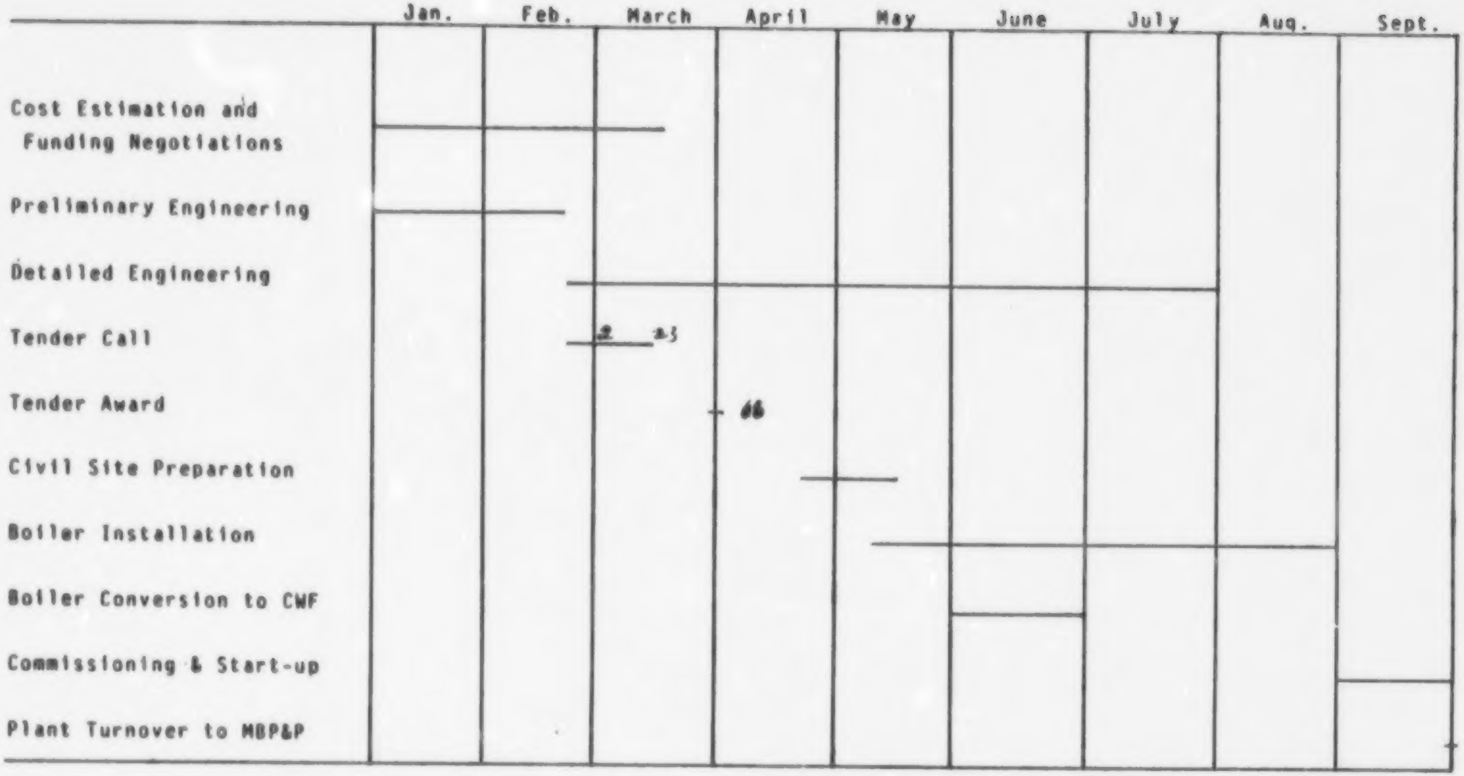


Figure 5.1: Project Schedule

Commissioning of the system will begin on September 1, 1987, and is scheduled over the following 30 days. At the end of September the start-up phase will be complete and the boiler and equipment ready for turnover to MBP&P for operation.

Monitoring of system performance and reporting will continue for up to two years beyond plant turnover. By this time, all project objectives outlined in this proposal will have been achieved.

6. COST ESTIMATE

The total cost of this demonstration project including engineering, capital cost of equipment, installation and commissioning, manpower for planning, and supervision and monitoring of system performance is estimated at $2,130,900. A breakdown of this cost is shown in Table 6.1.

Table 6.1: Project Cost Breakdown

Cost Element	Amount
Equipment, installation and commissioning	$ 757,900.
Engineering	113,000.
Coal	1,260,000.
TOTAL PROJECT COST	$ 2,130,900.

The budget estimate shown in Appendix III, Figure A-3 gives a further breakdown of the equipment installation and commissioning component - $757,900. This budget is a Class B estimate and will be further tightened as tendered bids are received. The CBDC engineering component ($113,000.) represents approximately 15% of the equipment and installation cost. The coal component is calculated on a present day fair market value for thermal coal of $50 per tonne. 12,600 tonnes per year for two years will be required to produce an estimated 36,000 t of CWF. The coal cost does not constitute any portion of the fuel price to Minas Basin Pulp and Power in order that the CWF may be sold to MBP&P at an equivalent oil price. Such a pricing strategy, critical to project approval by MBP&P, covers only the processing and transportation costs and the cost of the coal thus becomes a cost to the project.

7. COST SHARING PROPOSAL

In the process of developing the concept of this first continuous CWF user project into a workable plan, it became essential to reduce the capital investment of Minas Basin Pulp and Power to a maximum of $100,000.00 with the assurance that fuel costs will not exceed the equivalent price MBP&P pay for #6 oil. Since CWF costs more to produce and deliver to MBP&P than they are presently paying for HFO, it will be necessary to subsidize CWF production costs. The Cape Breton Development Corporation has agreed to contribute coal for a two year period, to a maximum total of 25,200 tonnes of coal. At present day oil prices and a fair market value of $50/t for the coal, the contribution represents $1,260,000.00.

In order to control and minimize costs to the project, CBDC will contribute the majority of the engineering, administration and reporting services required. The estimated value of these services is $113,000.00.

The total of these contributions from MBP&P and CBDC is $1,473,000.00. The balance required to complete the project is $657,900.00. Support is available from the Nova Scotia Canada Oil Substitution Agreement Fund (OSF) in the amount of $300,000. An additional $57,900.00 will be made available from accrued interest on OSF funds, leaving a balance of $300,000.00 to be secured in order to make the project possible. The Cape Breton Development Corporation proposes a Canmet contribution to the capital cost of the project in the amount of $300,000.00 plus advisory support from the CWF combustion experience and expertise of Canmet. Such a contribution from Canmet will be applied to the following components of the detailed conversion cost estimate shown in Figure A-3, up to $300,000: #14 - civil site preparation; #15 - boiler installation; #30 - CWF burner; and #43 - data acquisition.

The proposed cost sharing scheme is outlined in Table 7.1.

Table 7.1: Proposed Cost Sharing Scheme

Contributor	Amount
CBDC	1,373,000.00
MBP&P	100,000.00
OSF	300,000.00
OSF (interest)	57,900.00
CANMET	300,000.00
TOTAL	2,130,900.00

8. DELIVERABLE ITEMS

The Cape Breton Development Corporation agrees to submit to the Scientific Authority, designated in the terms of the DSS Agreement, the following items:

1) A quarterly summary report outlining progress to date, budget and schedule review and any other important information.
2) A final detailed report which will include: all aspects of work undertaken in this project and as outlined under Technical Proposal - Section 3; all relevant drawings, photographs and video recordings; all problems encountered and solutions engineered during the completion of the proposed work; an evaluation of the objectives outlined in Section 3.2.4 including any required support documentation; and answers to the 3 questions posed in the Introduction - Section 1. The information provided in the report will be sufficient to facilitate any further evaluation of the work by the Scientific Authority. The final report will be submitted not later than six (6) months after completion of the work outlined in this proposal. "Completion of the work" is identified as two years from the date of plant turnover which is scheduled for September, 1987. According to this schedule, the submission date for the final report is March, 1990.

9. SCIENTIFIC MERIT, UNIQUENESS AND BENEFITS

This section presents a brief outline of factors which demonstrate the scientific merit, the uniqueness and the benefits of this first industrial conversion and committment to continuous use of CWF.

9.1 Scientific Merit

This project offers several elements of scientific interest:

- an application of the CWF combustion technology developed by the Canadian Government since 1982 and as yet unapplied on a continuous long term basis;
- an opportunity for investigation of performance characteristics and economics of an oil-fired system converted to CWF;
- the development of a control management and data acquisition system for a CWF fired industrial boiler;
- further advancements in the science of CWF production technology, quality control and fuel handling.
- an opportunity to develop the technology for utilizing coal fines from the V.J. Coal Preparation Plant as feedstock.
- an opportunity to observe any changes in the combustion performance of CWF as the chemical additives are modified in the production of Carbofuel.

9.2 Uniqueness

The Cape Breton Development Corporation is the only producer of coal-water fuel in Canada with the capacity to meet the fuel requirements and provide the necessary production, quality control, fuel handling, combustion and applications experience that will be essential to the project.

No other company has developed the opportunity necessary for a first industrial conversion to long term continuous use of CWF and has the resources available on which to draw to contribute as significant an effort as CBDC is proposing.

9.3 Benefits

With the large financial committment the Federal Government has already provided for the development of CWF technology in Eastern Canada, it is important to not let the technology erode through lack of application. The successful undertaking of this conversion project will enable the realization of numerous benefits:

- development of CWF technology will be kept alive and progressing;
- opportunity to gain meaningful, long-term, continuous operation experience on the Canmet/NRC burner system, a converted oil-designed package boiler and fuel handling equipment;
- CBDC's position of nearness to commercialization will be maintained while the world oil price recovers;
- enhancement of the Canadian government's profile in new energy technologies;
- availability of an operating CWF user to show other Atlantic Canadian industries as an encouragement to convert to CWF when the economic climate is favorable;
- reduction of CBDC losses through use of V.J. fines as CWF feedstock;
- maintenance of approximately 20 jobs comprised of skilled technologists experienced in CWF production at the Carbofuel plant;
- support for service industries regularly providing the CWF plant with materials, supplies and services.

APPENDIX I

CARBOFUEL PRODUCTION PROCESS

Carbofuel Production

The CBDC-Carbofuel process configuration remains basically unchanged since its original design. However, a number of significant upgrading modifications have been made in the areas of feed, control and mixing. Figure A-1 shows a diagram of the process flow.

Coal is processed in the following sequence:-

(1) Raw coal is fed through a hammermill crusher to reduce the topsize to 1/2"; the crusher discharges into a storage hopper.

(2) Crushed coal is discharged from the hopper onto a variable speed conveyor. On-line moisture analysis and belt scale weighing control the feedrate into the ball mill.

(3) The coal is wet ground in the ball mill.

(4) The mill discharge is screened in a multi-stage configuration. The combined screen underflows are sent to flotation.

(5) The screen circuit overflow is returned to the ball mill for further grinding.

(6) The flotation product is collected and sent to the Vacuum Filters for dewatering.

(7) The flotation tailings are combined and sent to effluent.

(8) The Vacuum Filter filtrate is returned to flotation.

(9) The Vacuum Filter product (filtercake) is carried by conveyor to the mixing stage; the flowrate and moisture are measured on-line.

(10) The filtercake is passed through a shredder, with dispersant and defoamer added, to disperse the coal and coat the particles with chemical.

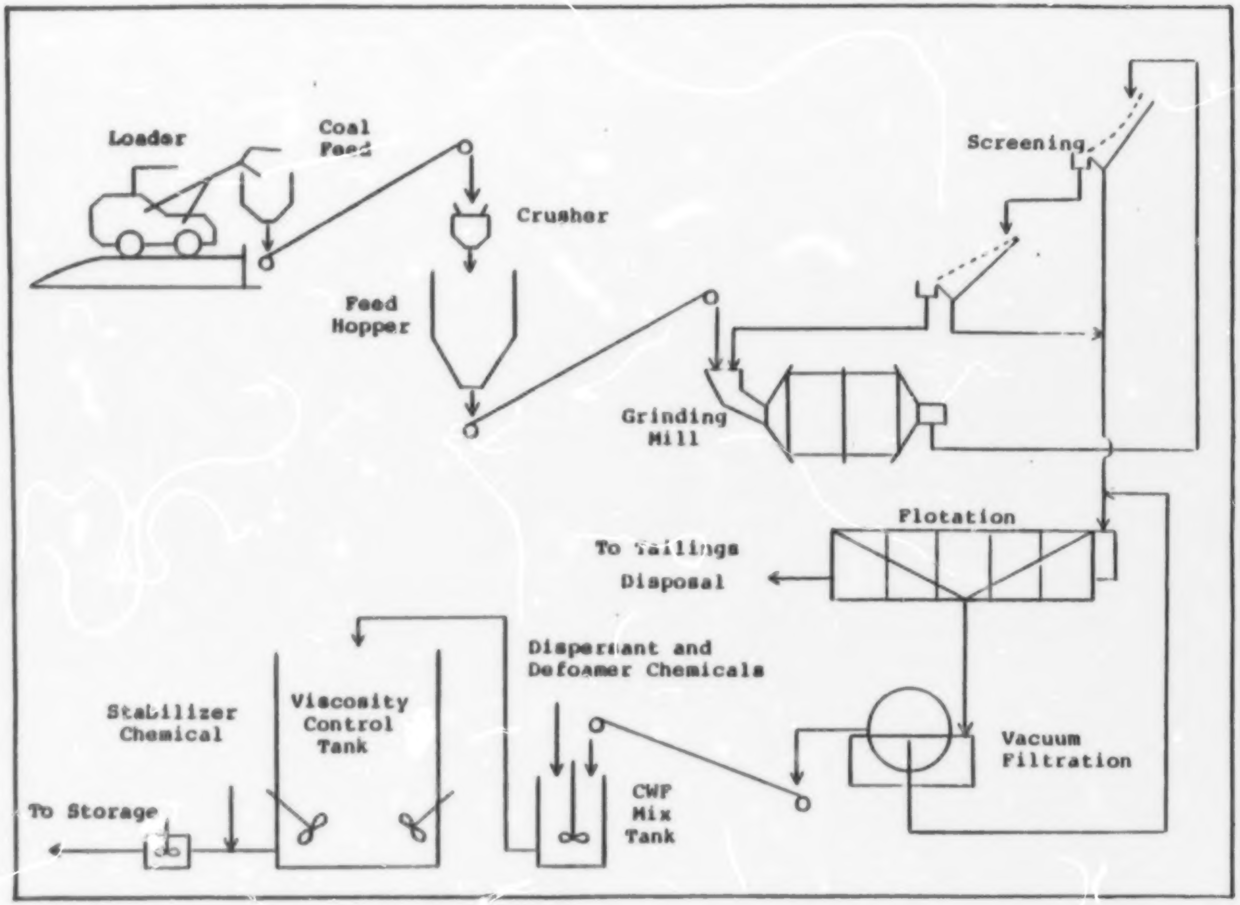

Loader
Coal Feed
Crusher
Feed Hopper
Screening
Grinding Mill
Flotation
To Tailings Disposal
Dispersant and Defoamer Chemicals
Vacuum Filtration
Stabilizer Chemical
Viscosity Control Tank
CWF Mix Tank
To Storage

Figure A-1 Carbofuel Process Diagram

(11) The fine filtercake product is wetted and mixed into a raw fuel product in the mix tank; make-up water is added automatically as required.

(12) The mix tank discharge is pumped into the Viscosity Control tank for conditioning and homogenization.

(13) The Viscosity Control Tank discharge is pumped through an in-line mixer with stabilizer added, and into the Agitated Storage.

(14) Biocide is added in the agitated storage and final conditioning takes place there.

(15) CWF product is transferred into Final Storage.

(16) CWF product is loaded for shipment from the Final Storage.

An optional Fines Processing circuit can be utilized as well. In this operating mode V.J. Fines from the Coal Preparation Plant nearby are pumped into the Carbofuel circuit at the screening stage. The screen circuit overflow goes into the Secondary Ball Mill for fine grinding. The Secondary Ball Mill discharges back into the screening circuit. The rest of the processing is unchanged.

Process Control

The CBDC-Carbofuel production process incorporates extensive automatic control. Instrumentation measures various process parameters and sends the data to controllers and/or a central data logging system. The objective of this control is to maintain the operating conditions at steady state to ensure consistent production results.

In critical areas, such as the grinding/classification section, the mixing station, and product loadout fully automated controls have been implemented. In addition, flows, moisture levels, densities, tank levels, temperature, and the on/off status of all electrical equipment are transmitted via an Allen-Bradley programmable logic controller (PLC) to an IBM-AT computer, where the information is displayed in graphic form and stored for report generation and analysis. All electrical equipment within the plant can be controlled from the PLC console where there are one-button start sequences for each area of the plant and individual push buttons for each piece of equipment.

Along with computerized monitoring, a second computer will serve as backup and will be interfaced to various pieces of lab instrumentation. This second unit will be used mainly for data analysis, simulation programs, optimization programs, inventory control, accounting, and production tracking.

CARBOFUEL PRODUCTION QUALITY CONTROL

A management structure, as illustrated in Fiqure A-2, constitutes the manner in which plant personnnel are organized to operate the plant most effectively. Quality control in the Carbofuel production process has been developed to ensure the fuel product falls within the defined specification. For each client a specification is drawn up which defines the major parameters for an acceptable product. A sample specification is attached as Schedule A.

In order to maintain the fuel quality within specification the parameters of particle size distribution, rheology and final product quality must be controlled. These are the main areas of focus in quality control.

(a) Particle Size Control

An acceptable particle size distribution (psd) range has been determined for CBDC produced Carbofuel CWF. The target range is indicated in Figure 5. The psd affects the CWF in three ways: (1) it determines the maximum solids loading, as determined by particle packing; (2) it affects the dispersant requirement, as determined by surface area; and (3) it influences fluid properties, as determined by particle interactions. The critical aspect of the psd is that it be broad, i.e. particles spread over a wide range of sizes without too high a concentration in any area.

A number of parameters determine the psd produced in the grinding circuit. These include: (1) the ball charge; (2) the coal feed properties; (3) the coal feedrate; (4) the solids concentration in the ball mill; and (5) the circulating load. The specific control in the grinding circuit is designed to optimize these parameters to give the desired psd.

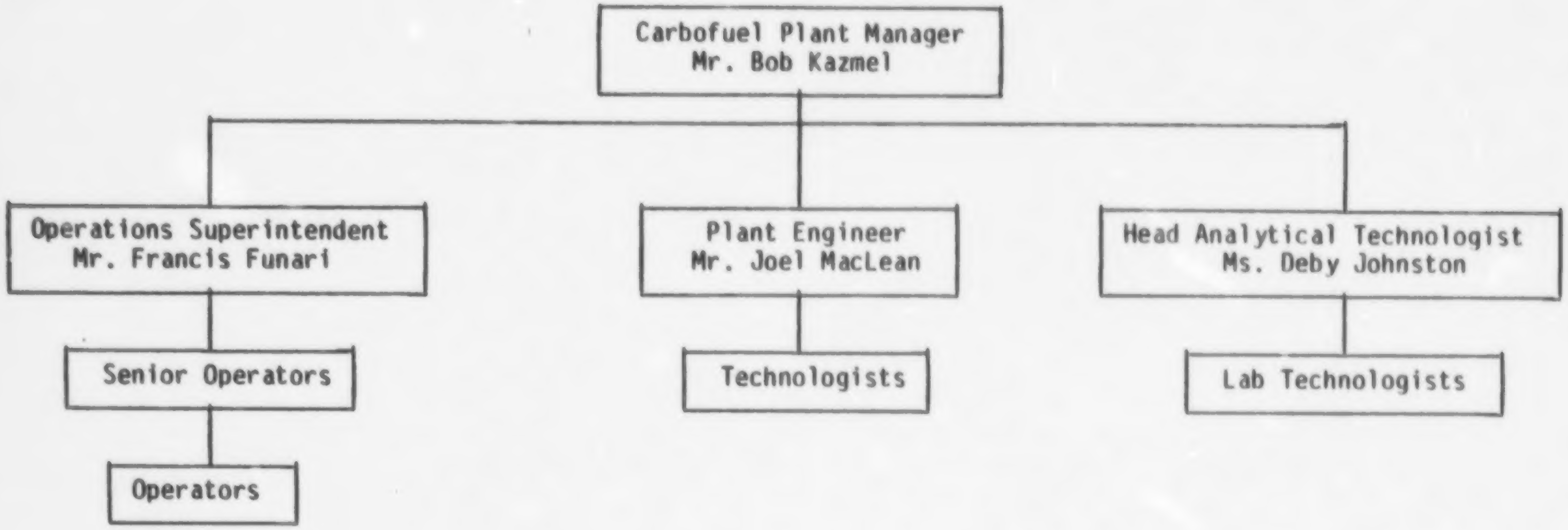

Carbofuel Plant Manager
Mr. Bob Kazmel
Operations Superintendent
Mr. Francis Funari
Senior Operators
Operators
Plant Engineer
Mr. Joel MacLean
Technologists
Head Analytical Technologist
Ms. Deby Johnston
Lab Technologists

Figure A-2: Carbofuel Production Plant Management Structure

The first two parameters are considered constant (the ball charge is preset). The feedrate is determined for the appropriate solids concentration and circulating load, and is held at that level. The psd is controlled by fine-tuning these last three parameters as required. For example, a lack of fines means a longer retention time is required, and this is provided for by reducing the water addition rate (increasing the solids concentration) and/or reducing the feedrate; the opposite procedure applies for an excess of fines.

(b) Rheology Control

Rheological measurement describes the flow characteristics of the raw fuel and final product. This is done as a profile of viscosity vs. shear rate. A good viscosity profile indictes that all the fuel parameters are acceptable. The parameters which determine the rheology are: (1) psd; (2) solids loading; (3) chemical concentration; and (4) mixing.

From a fuel sample taken from the mixing circuit it can be determined which, if any, parameters must be adjusted in the process. Each parameter can be tested separately, but the viscosity profile often indicates which one should be checked more closely. It is important to take all the parameters into consideration when evaluating a given sample.

(c) Final Product Quality

The client specifications define the parameters of final product quality. By maintaining process control during production the fuel sent to final storage will be of the proper specification. Monitoring of the fuel in storage will serve to keep track of it prior to shipment.

Through a routine sampling and analysis program, fuel in storage is monitored to ensure no changes occur in the fuel quality. An "active inventory" of fuel on hand is kept so that only CWF that is ready for shipment will be loaded.

SCHEDULE A

CARBOGEL SPECIFICATIONS
From CBDC Harbour Seam Coal

	Typical	Limits
1) Proximate - Dry Basis		
Ash %	1.7	2 Max.
Sulphur %	0.9	1.2 Max.
Volatile %	37.0	36.0 Min.
2) Ultimate (Dry Ash Free)		
Carbon	87.0	85.0 Min.
Hydrogen	5.8	5.5 Min.
Nitrogen	1.3	1.6 Max.
Sulphur	.9	1.2 Max.
Oxygen	5.0	6.0 Max.
Ash Fusion (Oxidizing Mode)	1432°C (ST)	
3) Heating Value - Dry Basis		
BTU per pound (dry)	15,000	14,800 Min.
BTU per pound (As received)	10,500	10,400 Min.
Kilojoules/Kg	35,000	34,500 Min.
4) Specific Gravity		
	1.15	1.10 Min.
5) Water Content %	30.0	32.00 Max. 29.00 Min.
6) Viscosity (cp)		
At 25.6 Sec. -1 Shear Rate	1000	1200 Max.
Viscosity Decrease from that at 75 sec. -1 to that at 452 sec. -1 when shear rate is increased from Zero to 452 sec. -1 over 2.24 minutes	300	200 Min.
(Viscosity measurements by Contraves Rheomat 115)		
7) Particle Top Size - Microns		
Maximum Particle Size	250	400

* - Particle Top Size is application dependent.

** - Limits do not necessarily correlate to be a quality fuel.

APPENDIX II

PROJECT PERSONNEL

CURRICULUM VITAE

JOHN ROBERT KAZMEL

EDUCATION

University College of Cape Breton, Sydney, Nova Scotia.
Presently pursuing BBA (Evenings).

University College of Cape Breton, Sydney, Nova Scotia.
Professional Managers Designation. Canadian Institute of Management - 1985.

University College of Cape Breton, Sydney, Nova Scotia.
Management and Administration Certificate - 1984.

Nova Scotia Eastern Institute of Technology, Sydney, Nova Scota.
Diploma in Engineering Technology (Mineral) - 1970.

Nova Scotia Teachers' College, Truro, Nova Scotia.
Industrial Arts - 1967.

COMPANY SPONSORED COURSES

Cape Breton Development Corporation, Sydney, Nova Scotia.

Supervisory/Management Training Phase 11, Performance Appraisals, Corrective Discipline, Management Guide to Loss Control, 1984 - 1986.

Atomic Energy of Canada Limited, Candu Operations, Glace Bay, Nova Scotia.

Interactive Management, Labour Relations, Time Management, Analytic Trouble Shooting, Confined Space Hazard Control, Performance Appraisal Systems, Interviewing Techniques, Accident Investigations, Motivation/Leadership, Process Control Techniques, Negotiations, Technical Report Writing - 1979 - 1984.

WORK EXPERIENCE

Cape Breton Development Corporation, Sydney, Nova Scotia.

1984 - Present	Plant Manager - Reporting to the Director of New Process Technology. Responsible for the overall direction and management of the Corporation's Coal Water Fuel Plant.

Additional duties include Project Manager for all major projects within the department with ultimate responsibility for their successful completion. Successfully completed a $2,600,000 plant upgrading resulting in a favourable budget variance. Received 4-Star management Rating from the International Loss Control Institute during a recently conducted Corporate Management Audit. Controllable budget: $5,240,000.00.

Atomic Energy of Canada Limited, Candu Operations, Glace Bay, Nova Scotia.

1983-1984

Laboratory Supervisor - Reporting to Production Manager, with technical and production responsibility for all plant utilities. Additional duties included control of plant raw material, inventory and consumption, operations budgeting, production forcasting, daily production yield analysis. Group leader for Information System Development in Operation's Department. Controllable budget in excess of $5,000,000.00.

1980-1983

Laboratory Supervisor - Supervised 10 Chemical Technologists, administered collective agreement, scheduled manpower-overtime, down from 18% - 1%. Generated budgets in excess of $500,000, controlled expenditures resulting in a budget saving of 14%. Expanded laboratory functions to include technical responsibilities for a 32,000,000 gal. water treatment plant and a 1,000,000 gal. cooling tower. Responsible for 35 on-line process monitors.

1978-1980

Senior Technologist - Maintained and improved operation and reliability of laboratory instruments including on-line infrared spectrometer. Conducted non-routine analysis, rebuilt scrapped mass spectometer and placed in continuous service (replacement value $250,000). Automated operation of lab instruments with Apple Computer. Set up an in-house training program for technologists.

1976-1978 Laboratory Leader - Conducted non-routine analysis. Developed analytical techniques, solved special sampling problems, wrote section of laboratory procedure manual, trained Junior Technologists.

1973-1976 Laboratory Technologist - Conducted routine and non-routine analysis. Direct involvement in plant commissioning, helped resolve special start up problems, trained Junior Technologists.

Kaiser Strontium Products Ltd., Sydney, Nova Scotia.

1971-1973 Development Technologist - Direct involvement in commissioning and start up of both mining and milling operations. Conducted routine and non-routine analysis. Direct involvement in mineral waste recovery projects to resolve plant operating problems. Aided in the development of waste recovery process, which substantially increased total plant production and recovery.

Mokta Canada Limited, Uranium City, Saskatchewan.

1970-1971 Assistant Geologist - Conducted geophysical and geochemical surveys. Directed the work of four line cutters. Performed Assay analysis. Drafted contour maps, took part in the initial exploration which led to the uranium find at Cluff Lake, Saskatchewan.

PROFESSIONAL MEMBERSHIPS

Member of the Canadian Institure of Management.

Member of the Chemical Technology Advisory Committee, University College of Cape Breton.

Member of the International Loss Control Institute.

CURRICULUM VITAE

GREG LANDRY

EDUCATION

Dalhousie University, Halifax, N.S. - 1979
Diploma in Engineering

Technical University of Nova Scotia - 1982
Bachelor of Engineering (Metallurgy)

WORK EXPERIENCE

Cape Breton Development Corporation, Sydney, Nova Scotia.

1986 - Present	Process Engineer - Responsible for coal processing and related developments, mainly in the CWF (coal-water fuel) field. Includes production and quality analysis, special projects, and related technical developments. The position had a close involvement in a recent $2,600,000 plant upgrading. A current undertaking is the co-operative development with the Center for Energy Studies of Halifax, N.S. of a small scale fluidized bed furnace fueled with CWF.
1984 - 1985	Carbogel Quality Control Manager - Responsible for quality control in the CWF production plant. The plant has supplied CWF to the New Brunswick Electric Power Commission and the Iron Ore Comapny of Canada for major demonstrations. The position also included production related functions such as process development and equipment specification.
1982 - 1983	Research Engineer - This position included project related functions in the Coal Technology Developments department. The main respsonsibility was to carry out field work, typically with an outside interest working jointly on the project. These projects were in coal recovery, coal processing, and related areas. Job functions included project co-ordination, liaison and reporting.

PROFESSIONAL MEMBERSHIPS

Member - Association of Professional Engineers of Nova Scotia

Vice Chairman - CLM Working Group.

CURRICULUM VITAE

JOEL MACLEAN

EDUCATION

Diploma of Engineering, Dalhousie University, 1978.

Bachelor of Engineering (Metallurgical), Technical University of Nova Scotia, 1981.

WORK EXPERIENCE

Cape Breton Development Corporation, Sydney, Nova Scotia.

1985 - Present

Plant Engineer - Responsible for all technical aspects of the CWF production facility. This encompasses development, implementation and documentation of technical solutions to process problems, including development of engineering standards, process/computer interfaces and MIS support systems.

Developed and implemented control strategies for the production of CWF, which resulted in the complete automation of the Carbofuel Production Plant.

Developed and implemented equipment/computer interfaces for automation of laboratory analytical equipment.

Sydney Steel Corporation, Sydney, N.S.

1983 - 1985

Research and Development Engineer. Responsible for design, development and installation of data collection, production recording and MIS systems for the quality control department, including operator training.

Developed and implemented a data collection and reporting system for production recording and statistical quality control throughout the plant, using a multi-user, time sharing computer system. Also, developed specialized programs for blast furnace optimization and control.

Held responsibility for quality control in the blast furnace department.

1982 - 1983 Instrument Engineer. Responsible for design of control/monitoring systems for installation in various locations throughout the plant, along with selection and installation of instrumentation to achieve desired control strategies. This included supervision of instrument personnel in the maintenance of existing analog and pneumatic instrumentation.

As a team member, assisted in the design of control strategies and the selection of process equipment and instrumentation for the ugrading of the corporation's #3 blast furnace (phase 1 modernization).

1981 - 1982 Open Hearth Metallurgist. Responsible for quality control in steel making shop. Supervised chemical heat recorders and observers in shop.

Carried out various studies related to furnace optimization and steel quality in the steel making shop, which resulted in a reduction of seam defects in rails by sulfur and oxygen control in the steel making process.

PROFESSIONAL AFFILIATIONS

Member of Association of Professional Engineers of Nova Scotia.

CURRICULUM VITAE

AUBREY PALMETER

EDUCATION

Dalhousie University, Halifax, N.S.
Master of Business Administration (1986)

Technical University of Nova Scotia, Halifax, N.S.
Bachelor of Engineering in Civil Engineering with Distinction (1980).

Acadia University, Wolfville, N.S.
Bachelor of Science in Mathematics and Physics: Certificate of Applied Science (1978).

WORK EXPERIENCE

Scotia Investments Ltd., Halifax, N.S.

1986 - Present Group Energy Co-Ordinator - Responsible for the management of energy purchasing and use within a group of nine assorted companies making up the Scotia Investments Group.

Imperial Oil Ltd., Halifax, N.S.

1982 - 1986 Industrial Representative - Represented Imperial Oil to Industrial customers in Cape Breton. In 1982 moved to Halifax to assume marketing management and strategic planning for primary fuel sales throughout Nova Scotia.

1980 - 1981 Project Engineer - Responsible for planning and construction of Eastern Canadian warehouse, bulk storage depots, and other petroleum distribution facilities.

PROFESSIONAL MEMBERSHIPS

Member - Association of Professional Engineers of Nova Scotia.

APPENDIX III

DETAILED CONVERSION
COST ESTIMATE

Figure A-3: Detailed Conversion Cost Breakdown

Unit	Description	Original Budget	Revised Budget	Variance	Actual	Sum Of Req.Amt.	Sum Of Inv.Amt.	Est. To Comp.
11	BOILER PURCHASE	60,000.00	60,000.00	0.00	60,000.00	0.00	0.00	60,000.00
12	BOILER REMOVAL	14,000.00	14,000.00	0.00	14,000.00	0.00	0.00	14,000.00
13	BOILER TRANSPORT	8,000.00	8,000.00	0.00	8,000.00	0.00	0.00	8,000.00
14	CIVIL SITE PREPARATION	62,000.00	62,000.00	0.00	62,000.00	0.00	0.00	62,000.00
15	BOILER INSTALLATION	90,000.00	90,000.00	0.00	90,000.00	0.00	0.00	90,000.00
10	BOILER	234,000.00	234,000.00	0.00	234,000.00	0.00	0.00	234,000.00
21	TANK FOUNDATION-CLAY DYKE	10,000.00	10,000.00	0.00	10,000.00	0.00	0.00	10,000.00
22	TANKS	30,000.00	30,000.00	0.00	30,000.00	0.00	0.00	30,000.00
23	PIPE SUPPORTS	5,000.00	5,000.00	0.00	5,000.00	0.00	0.00	5,000.00
24	FUEL PIPING SYSTEM	18,000.00	18,000.00	0.00	18,000.00	0.00	0.00	18,000.00
25	OFF LOADING PUMP	10,000.00	10,000.00	0.00	10,000.00	0.00	0.00	10,000.00
26	FUEL TRANSFER PUMP	15,000.00	15,000.00	0.00	15,000.00	0.00	0.00	15,000.00
20	FUEL HANDLING SYSTEM	88,000.00	88,000.00	0.00	88,000.00	0.00	0.00	88,000.00
31	CWF ATOMIZER (NRC)	18,000.00	18,000.00	0.00	18,000.00	0.00	0.00	18,000.00
32	CWF BURNER (CANMET)	42,000.00	42,000.00	0.00	42,000.00	0.00	0.00	42,000.00
33	BURNER INSTALLATION	36,000.00	36,000.00	0.00	36,000.00	0.00	0.00	36,000.00
34	CWF IGNITOR	7,000.00	7,000.00	0.00	7,000.00	0.00	0.00	7,000.00
35	AIR HEATER	40,000.00	40,000.00	0.00	40,000.00	0.00	0.00	40,000.00
36	BALANCED DRAFT INSTALLATION	20,000.00	20,000.00	0.00	20,000.00	0.00	0.00	20,000.00
30	CWF BURNER	163,000.00	163,000.00	0.00	163,000.00	0.00	0.00	163,000.00
41	CONTROLLERS, PANEL, ETC.	35,000.00	35,000.00	0.00	35,000.00	0.00	0.00	35,000.00
42	BURNER MANAGEMENT/LOGIC	30,000.00	30,000.00	0.00	30,000.00	0.00	0.00	30,000.00
43	DATA ACQUISITION	34,000.00	34,000.00	0.00	34,000.00	0.00	0.00	34,000.00
44	TRANSMITTERS, FLOW ELEMENTS	30,000.00	30,000.00	0.00	30,000.00	0.00	0.00	30,000.00
45	MAGNETIC FLOWMETERS	6,000.00	6,000.00	0.00	6,000.00	0.00	0.00	6,000.00
46	CONTROL VALVES, POSITIONERS	18,000.00	18,000.00	0.00	18,000.00	0.00	0.00	18,000.00
47	AUTO VALVES, PIs, TIs, ETC.	20,000.00	20,000.00	0.00	20,000.00	0.00	0.00	20,000.00
48	ELECTRICAL CABLE TRAYS	5,000.00	5,000.00	0.00	5,000.00	0.00	0.00	5,000.00
49	SUPPLY & INS. OF MAIN POWER	10,000.00	10,000.00	0.00	10,000.00	0.00	0.00	10,000.00
50	HEAT TRACE & INSULATION	16,000.00	16,000.00	0.00	16,000.00	0.00	0.00	16,000.00
40	ELECTRICAL & INSTRUMENTATION	204,000.00	204,000.00	0.00	204,000.00	0.00	0.00	204,000.00
60	PROJECT CONTINGENCY	68,900.00	68,900.00	0.00	68,900.00	0.00	0.00	68,900.00
60	PROJECT CONTINGENCY	68,900.00	68,900.00	0.00	68,900.00	0.00	0.00	68,900.00
70	CAPITAL RECOVERY							
70	CAPITAL RECOVERY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL		757,900.00	757,900.00	0.00	757,900.00	0.00	0.00	757,900.00

APPENDIX B

TENDER DOCUMENT

TENDER FOR THE COAL-WATER FUEL CONVERSION OF AN INDUSTRIAL OIL-FIRED PACKAGE BOILER IN A PULP AND PAPER PLANT, HANTSPORT, NOVA SCOTIA

MAR 1 1 1987

MAR [illegible] 987

INDEX

SECTION 1. INSTRUCTIONS TO TENDERERS

SECTION 2. FORM OF TENDER

SECTION 3. ARTICLES OF AGREEMENT

SECTUIB 4. GENERAL CONDITIONS

SECTION 5. GENERAL REQUIREMENTS

SECTION 6. DESCRIPTION OF WORK

SECTION 7. DRAWINGS AND SPECIFICATIONS

Section 1 - Instructions to Tenderers

1. Submission of Tenders
2. Signing of Tenders
3. Validity of Tenders
4. Questions During Tender Period
5. Site Visit
6. Bonding
7. Material Variations
8. Summary of Work
9. Material/Equipment Supplied by the Purchaser
10. Schedule of Work
11. List of Drawings

INSTRUCTIONS TO TENDERS

Bid No.: ______________________________

Bid Name: Minas Basin Pulp & Power CWF Project

1. Submission of Tenders

Tenders for the work described in these Tender Documents will be received at the following address until 2. P.M. local time April 6, 1987 :
DATE

Minas Basin Pulp & Power Co. Ltd.
Hantsport, N.S.
Attention: Mr. Peter Zwicker

Tenders received after the date and time stated above will be returned unopened to the Tenderer.

Tenders shall be submitted on the Form of Tender provided in these Tender Documents along with one duplicated copy of the form of Tender.

Tenders shall be submitted in a sealed opaque envelope with the address as indicated above and clearly marked on the outside as follows:

Bid No. ___________

Bid Name: Minas Basin Pulp & Power CWF Project

Tenders submitted verbally, by telegraph, telex or other similar means will not be considered.

The Tenderer shall return all tender documents to the Purchaser within seven (7) days of notification of non-award to tender.

2. Signing of Tenders

Tenders shall be signed by the person or persons making the Tender. Tenders signed on behalf of Corporations must contain the Corporate Seal and be signed by an authorized representative of the Corporation.

3. Validity of Tenders

Tenders shall be valid for a period of sixty (60) calendar days from the Tender closing date stated in 1.

Bid No.: ______________________

Bid Name: Minas Basin Pulp & Power CWF Project

4. Questions During Tender Period

Tenderers who find errors or omissions in the Tender Documents or who require clarifications shall advise the Purchaser, who, according to the need, may issue written clarification to all Tenderers.

Such questions shall be directed to:

Minas Basin Pulp & Power Co. Ltd.
P.O. Box 401
Hantsport, N.S.
B0P 1P0

During the tender period, Tenderers may be advised by means of Addendum of additions, deletions or revisions to these Tender Documents. These addenda shall be referred to in the form of Tender and become part of the Tender submission.

5. Site Visit

Tenderers are required to visit the site and to become familiar with all aspects of the work. Attention is drawn to General Conditions GC-3 "Knowledge of Site".

6. Bonding

Bonding may be required in accordance with General Conditions GC-5 "Contract Security". An "Agreement to Bond" certificate from a recognized Bonding Company shall be attached to the Form of Tender.

A Bid Bond in the form of a certified cheque in the amount of ten percent (10%) of the total tendered price is required to be submitted with the Form of Tender.

7. Material Variations

The Tenderer shall list any material variation, which the tenderer proposes to use in accordance with the following:-

Bid No.: ______________________________

Bid Name: Minas Basin Pulp & Power CWF Project

Tenders shall be based upon using items indicated by reference to a manufacturer's name, by trade name or brand name, or by catalogue reference. Where two or more names or brands are specified, the choice shall be optional with the Contractor.

Any variation shall be listed under "Material Variations" in the appropriate appendix to the Form of Tender showing the item for which a variation is proposed as well as the name and complete specifications and stating the reason for variation and what difference, if any, will be made in the amount of the proposal for each should it be accepted. A separate sheet (s) will become part of the Form of Tender documents.

The additions or deductions from the amount payable to the Contractor shall include any modifications of work or any additional work that may be required by reason of the acceptance of the Material Variation.

The proposed material variations as outlined will be reviewed after tender closing.

8. Summary of Work

The scope of work is as follows: relocation of a used 60,000 lb/hr package boiler, auxiliary equipment and stack to the worksite described under General Requirements (Section 5.1); installation of the boiler, auxiliary equipment and stack; design, supply and installation of a combustion air heater and balanced draft system including all related ductwork; piping installation; modification of the boiler to burn coal water fuel and; the supply and installation of CWF burner and ignitor.

9. Material/Equipment Supplied by the Purchaser

A list of material/equipment supplied by the Purchaser is given in Section 7.1.

10. Schedule of Work

Tenderers shall complete the Schedule section of the Form of Tender. Tenderers shall also submit their proposed preliminary work schedule with the Form of Tender which demonstrates the sequence and timing of the various items of work to be performed to assist the Purchaser in the evaluation of Tenders. Tenderers shall ensure that suppliers of materials and equipment proposed for use on this work and included in the Tender Price can meet the proposed schedule - or the required dates as may be specified in other Sections.

11. List of Drawings

All drawings which form part of the Tender Documents are listed and contained in Section 7.4 and Section 7.5.

Section 2 - Form of Tender

1. Price
2. Schedule
3. Appendices
4. Bonds
5. Documents
6. The Undersigned Tenderer
7. Signature

Appendix 1: Schedule of Prices

Appendix 2: Sub-Contractors and Major Suppliers

Appendix 3: Tenderer's Proposed Organization

Appendix 4: Material Variations

FORM OF TENDER

Bid No.: ______________________________

Bid Name: Minas Basin Pulp & Paper CWF Project

Name of Tenderer______________________________________

____

______________________Telephone_______________________

1. Price

The Tenderer proposes to provide all the labour, materials, construction equipment and services and supervision to fabricate and install the work at Minas Basin Pulp & Paper Co. Ltd. in accordance with the Description of Work included in the Tender Documents and taking account of all Federal and Provincial sales taxes and excise taxes, customs duties, transport costs and all other charges, and accept as payment in Canadian funds the all inclusive Price of ____________.

A breakdown of this price is given in Appendix 1. This Schedule of prices will form an attachment to the Articles of Agreement in the Contract.

2. Schedule

The Tenderer recognizes that the proposed preliminary schedule of work to be executed (see Section 1.10) is an integral part of this Form of Tender and therefore acknowledges that the Tenderer has consulted with and obtained letters of agreements from all subcontractors and suppliers of material which would be used in this contract in respect of their ability to meet scheduled dates for the work, their ability to execute the work in accordance with the Purchaser's requirements and the prices upon which the materials or work may be provided.

The undersigned accepts, that if the Purchaser advises acceptance of the Tender:

To commence work __________weeks after award of the Contract

To commence work on site ______ weeks after award of the Contract

To have completed the contractual work ________ weeks after award of the Contract.

Bid No.: ______________________________

Bid Name: Minas Basin Pulp & Paper CWF Project

3. Appendices

The attached Appendices (Pages 5, 6, 7, 8) of this Form of Tender) have been completed by the undersigned and form an integral part of this Form of Tender.

Appendix 2 provides a list of major Suppliers and Sub-Contractors we propose to employ on the work of this Contract and we acknowledge that no change will be made to this list without the express written approval of the Purchaser.

4. Bonds

The costs of a Performance Bond and a Labour and Material Payment Bond in accordance with GC-5 of the General Conditions have been included in Item 1 of this Form of Tender.

An "Agreement to Bond" certificate from a recognized bonding firm is attached to this Form of Tender.

A Bid Bond in the form of a certified cheque for ten percent (10%) of the total price stated in Item 1 of this Form of Tender is attached.

5. Documents

The undersigned has carefully examined the site of the proposed work, transportation and access facilities to the site of installation and existing conditions, as well as the Drawings listed in the Instructions to Tenderers.

Any additional Canmet burner drawings required by the Tenderer for the purpose of preparing a tender submission can be obtained from: Minas Basin Pulp & Paper Co. Ltd., P.O. Box 401, Hantsport, N.S., B0P 1P0. The undersigned agrees to return to the Purchaser any and all documents supplied with or in addition to the Tender Document Package.

Also, the undersigned has thoroughly reviewed the Tenderer's Instructions to Bidders, Form of Tender, General Conditions, General Requirements, Description of Work, Drawings, Specifications, and the following Addenda and hereby accepts and agrees to the same as forming part and parcel of the proposed Contract.

Bid No.: ______________________________

Bid Name: Minas Basin Pulp & Paper CWF Project

Addendum No. ____________ dated ____________

Addendum No. ____________ dated ____________

Addendum No. ____________ dated ____________

6. The Undersigned Tenderer

The Tenderer agrees that this Tender is valid and subject to acceptance by the Purchaser for a period of sixty (60) days from date of receipt of Tenders, and that if notified of award of Contract shall;

6.1 Execute the Articles of Agreement within fourteen (14) calendar days of the Purchaser's written notification of intent to execute in accordance with this form to proceed immediately with the work.

6.2 Accept the Purchaser's written notification of intent to execute the Articles of Agreement as authorization to proceed immediately with the work.

6.3 Furnish to the Purchaser copies of insurance policies as required by the General Conditions 19.5.

6.4 Furnish the Purchaser within twenty-one (21) days a breakdown of the Contract Prices in such form and detail as required and in accordance with 37.1 of the General Conditions.

6.5 Within one week following notification to proceed with the work to submit to the Purchaser for review of a fully detailed schedule of operations for the work of this contract, including dates for delivery of all items, preparation and submission of shop drawings, fabrication and erection, with a breakdown of completed items and stages of the work.

6.6 Understands and agrees that the Purchaser is not bound to accept the lowest or any Tender which may be received.

6.7 Accept that quantities given and on which unit prices are based are subject to variation.

Bid No.: ______________________________

Bid Name: Minas Basin Pulp & Paper CWF Project

7. Signature

The Tenderer agrees that this tender supercedes and cancels all communications, negotiations and agreements relating to the work other than that contained in the completed tender.

SIGNATURE OF BIDDER

(
(
(______________________________
Name of Firm

(
(
(______________________________
Signed by

SEAL

(
(
(______________________________
Dated at

(
(
(This __________day of __________19___

Bid No. ____________________

Bid Name: Minas Basin Pulp & Paper CWF Project

Tenderer ____________________

Schedule of Prices

1.	Stack Removal:	- Includes removal from foundation and disassembly for transport:	________
2.	Stack Transport:	- Stack in two sections only, Glace Bay to Hantsport:	________
3.	Stack Installation:	- Assembly, erecting, orienting and securing to foundation:	________
4.	Boiler Removal:	- Includes boiler and supporting beams, deaerator, blowdown tank, chem. mix tank, feedwater pumps and motors, F.D. fan and motor, ductwork, dampers and access platform:	________
5.	Boiler Transport:	- Includes boiler and supporting beams, deaerator, blowdown tank, chem. mix tank, feedwater pumps and motors, and F.D fan and motor, and ductwork and attached components, Glace Bay to Hantsport:	________

Bid No. ____________________

Bid Name: Minas Basin Pulp & Paper CWF Project

6. Boiler Installation: - Locating, orienting, & securing boiler, deaerator, blowdown, chem. mix tank and feedwater pumps: __________

- All piping except CWF piping:

Materials: __________

Installation: __________

7. CWF Piping System: Materials: __________

Installation: __________

8. CWF Burner: Fabrication: __________

Delivery: __________

9. Burner Installation: Modification to boiler:

- Steel & structural mods: __________
- Refractory removal & replacement: __________

Installation of CWF Burner: __________

10. CWF Ignitor: Ignitor Fabrication: __________

Ignitor Delivery: __________

Ignitor Installation: __________

Bid No. ____________________

Bid Name: Minas Basin Pulp & Paper CWF Project

11. Balanced draft system: Engineering:

- Process Drawing: ________
- Balanced draft system design: ________

Fabrication/procurement:

- Air heater: ________
- ID fan w.bag house capability and 440 v. motor; ________
- Ductwork: ________

Delivery: ________

Installation: ________

12. Provincial Taxes: ________

13 Federal Taxes: ________

14. Insurance: ________

15. Duty, licenses, permits, certificates: ________

16. Total quotation ________

In addition and separate from Quotation Total:

1) Unit cost (for comparison) of ID fan sized without capability of handling baghouse pressure loss (see Section 6.3.2): ________

2) Daily per diem commissioning rate (see section 5.15): ________

3) Modification to boiler viewport, materials and labor (see Section 6.4.1): ________

4.) Bonding - Performance Bond: ________

- Labour and Material Bond: ________

Bid No.: ____________________________________

Bid Name: Minas Basin Pulp & Paper CWF Project

5.) Optional Secondary Air Cone Arrangement (14 1/2") (see Section 6.4.2) ____________

6.) Cost of coverage for protection against liquidation damages, at $30,000/day for total plant outage at MBP&P and CKF. ____________

FORM OF TENDER - APPENDIX 11 Pg. 9 of 11

Bid No. ______________________________

Bid Name: Minas Basin Pulp & Paper CWF Project

Tenderer __________________________________

Sub-Contractors and Major Suppliers

The undersigned proposes to retain the services of the following Sub-Contractors and Major Suppliers to assist with the work. No change to this list will be made without the express written approval of the Purchaser.

1. Sub-Contractors

Work	Name

2. Major Suppliers

Item	Name

FORM OF TENDER - APPENDIX 111

Bid No. ______________________________

Bid Name: Minas Basin Pulp & Paper CWF Project

Tenderer ___________________________________

Tenderer's Proposed Organization

Tenderer proposes to assign the following senior supervisory personnel to the work who shall perform the work in accordance with Articles of Agreement:

Title	Name	Experience	Location
Project Manager			
Site Superintendent			
Buyer			
Safety Supervisor			
General Foreman			
Office Manager			

FORM OF TENDER - APPENDIX 1V

Bid No. ________________________________

Bid Name: Minas Basin Pulp & Paper CWF Project

Tenderer _____________________________________

Material Variations

The following material variations are proposed by the Tenderer and we understand that these may be considered by the Purchaser during the tender evaluation period:

Reference No.	Proposed Substitution	Change in Price	
		Addition	Deletion

Section 3 - Articles of Agreement

1. Entire Agreement
2. Assignment of Contract
3. Performance and Date of Completion
4. Description of Work
5. Knowledge of Location
6. Warranty
7. Contract Amount
8. Purchaser Representative
9. Notice

ARTICLES OF AGREEMENT

THIS AGREEMENT made this day of

BETWEEN:

"SAMPLE"

(hereinafter called "Contractor")

OF THE FIRST PART

- and -

MINAS BASIN PULP & POWER CO. LTD.
a body corporate under the laws of
Nova Scotia, with Head Office at
P.O. Box 401, Hantsport, N.S.
(herein called the "Purchaser")

OF THE SECOND PART

WITNESS that in consideration for the mutual promises and obligations contained in the contract, the Purchaser and the Contractor covenant and agree as follows:

A1. ENTIRE AGREEMENT

1.1 The following documents and any amendments thereto form the entire contract between the parties:

1.1.1 these Articles of Agreement

1.1.2 the General Conditions

1.1.3 the General Requirements

1.1.4 the Description of Work

1.1.5 the Drawings and Specifications

1.2 In the event of discrepancies, inconsistencies or ambiguities of the wording of these documents, the wording of the document that first appears on the above list shall prevail over the wording of a document subsequently appearing on the list. In the event of discrepancies, inconsistencies or ambiguities between the drawings those of larger scale shall govern, those of later date shall govern.

1.3 No amendment or change in any of the provisions of the contract shall have force and effect until an amending agreement relating thereto shall have been executed by the parties; PROVIDED AND IT IS HEREBY UNDERSTOOD AND AGREED that revisions and updates of the Plans and Specifications, required in the opinion of the Purchaser during the term of the Contract, or updates of the Labour Conditions which may be required by Labour Canada, shall not necessitate formal amendment of the Contract, notwithstanding that such revisions and updates shall be deemed part of the Plans and Specifications or the Labour Conditions, as the case may be.

1.4 No implied terms or obligations of any kind on behalf of the Purchaser shall arise from anything in the contract and the express covenants and agreements therein contained and made by the Purchaser are the only covenants and agreements upon which any rights against the Purchaser are to be founded.

1.5 If any term, condition or provision of the Contract is held to be illegal or unenforceable, the same shall be considered severable and the remainder of the Contract shall remain in force and be binding upon the Parties as if such illegal or unenforceable term, condition or provision had never been included therein.

1.6 Time shall be of the essence of the contract.

1.7 The headings in the contract documents form no part of the contract but are inserted for convenience of reference only.

1.8 The contract shall enure to the benefit of and be binding upon the parties hereto and their lawful successors and assigns.

A2. ASSIGNMENT OF CONTRACT

2.1 The contract may not be assigned by the Contractor, either in whole or in part.

A3. PERFORMANCE AND DATE OF COMPLETION

3.1 Upon the terms and conditions of this contract, the Contractor shall:

3.1.1 provide and oversee the labour which shall, on behalf of and in the employ of the Contractor, diligently and in a careful and workmanlike manner perform the work specified in A4 herein to the satisfaction of the Purchaser, and

3.1.2 commence and actively proceed with the work within seven (7) days of the date of receiving written notice from the Purchaser to proceed with the said work unless otherwise specified in the notice and shall complete all work under this agreement on or before the ______ day of ___________ 19__.

A4. DESCRIPTION OF WORK

(See Section 6 of Tender Document).

A5. KNOWLEDGE OF THE LOCATION

A5.1 It is agreed that the Contractor has personal knowledge of the location of the proposed works and has information as to the actual conditions and requirements of the location in relation to the General Conditions of the Contract including but not limited to Labour Conditions and Labour Rules, G.C Appendix 1 and Contractor Safety/Loss Control, Security and Fire Protection Requirements as set out in GC 20 and shall not claim at any time after execution of the Contract that there was a misunderstanding in regard to such conditions and requirements.

A6. WARRANTY

A6.1 In consideration of the payments to be made by the Purchaser to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Purchaser to construct, complete, test and warrant the works to be in conformity in all respects with the provisions of the Contract to the satisfaction of the Purchaser.

A7. CONTRACT AMOUNT

A7.1 Subject to any increase, decrease, deduction, reduction or set-off that may be made under the contract, the Purchaser shall pay the Contractor, at the times and in the manner that is set out or referred to in GC 37 Payment, as follows:

7.1.1 the sum of $_______ in consideration for the performance of the work or the part thereof that is subject to a Fixed Price Arrangement.

PURCHASER REPRESENTATIVE

A8. For the purpose of this Contract, the Purchaser's Representative shall be Mr. Peter Zwicker

A9. NOTICE

A9.1 For all notices to be given under the contract, the contractor's address shall be deemed to be:

9.1.1 In the case of the Contractor

9.1.1 In the case of the Purchaser

IN WITNESS WHEREOF the parties hereunto have caused these presents to be executed, the day and year first above written.

SIGNED, SEALED AND DELIVERED) NAME OF FIRM
in the presence of:) Per:______________________
) Per:______________________
______________________)
WITNESS) MINAS BASIN PULP & POWER CO. LTD.
______________________)
WITNESS) Per:__________________________
)
) Per:__________________________

SECTION 4 GENERAL CONDITIONS

1. Definitions & Interpretations
2. Contract Documents
3. Knowledge of Site
4. Extent of Contract
5. Contract Security
6. Management of Construction
7. Labour Force - Contractor's Responsibilities
8. Unsuitable Personnel
9. Canadian Labour and Material
10. Interpretation of Contract by the Purchaser
11. Verbal Arrangements
12. Extension of Time
13. Notices
14. Purchaser's Property
15. Protection of Property
16. Clean Up of the Site
17. Cooperation with Other Contractors
18. Subcontracting
19. Insurance
20. Contractor Safety and Loss Control
21. Law of Contract
22. No Waiver
23. Notification of Regulatory Agencies
24. Environmental Laws
25. Patent Rights and Royalties
26. Public Ceremonies and Signs
27. Handling and Storage of Equipment
28. Provisional Certificate of Completion
29. Certificate of Completion
30. Warranty and Rectification of Defects
31. Changes in the Work
32. Valuation of changes in the Work
33. Changes in Soil Conditions
34. Mechanics Liens

35. Construction Schedule
36. Claims by Third Parties
37. Payment
38. Customs Duties
39. Records
40. Audit by the Purchaser
41. Final Plan
42. Taking Work Out of the Contractor's Hands
43. Suspension of the Work
44. Termination
45. No Partnership, Etc.
46. Connecting Work
47. Temporary Structures
48. Measurement of the Work

GC1. DEFINITIONS AND INTERPRETATIONS

1.1 In this contract (as hereinafter defined) the following words and expressions shall have the meanings hereinafter assigned to them except where the context otherwise requires:-

1.1.1 "Construction Equipment" means all fixed or mobile machines, tools or other things required in the execution of the Work, but does not include equipment, materials, or other things forming or intended to form part of the permanent Work.

1.1.2 "Construction Schedule" means the document described in GC35.1.

1.1.3 "Contract" means contract documents referred to in the Articles of Agreement.

1.1.4 "Contract Price" means the sum named in the Articles of Agreement of the construction, erection, completion, and testing of the Work subject to such additions thereto or deductions therefrom as may be under the provisions contained in the Contract.

1.1.5 "Purchaser" means the Minas Basin Pulp and Power Company, its duly appointed representative or such other person as may from time to time be appointed by MBP&P and notified in writing to the Contractor.

1.1.6 "Other Contractor" means any person, firm or corporation employed by or having a contract directly or indirectly with the Purchaser other than through the Contractor.

1.1.7 "Plans" means the Description of Work and drawings referred to in the contract and any modification of such Plans and drawings review in writing by the Purchaser and such other plans and drawings as may from time to time be furnished or reviewed in writing by the Purchaser for the purposes of the Contract.

1.1.8 "Site" means the lands and other places, on, under, in or through which the Work is to be executed or carried out and any other lands or places provided by the Purchaser for the purposes of the Contract.

1.1.9 "Sub-Contractor" includes only a person, firm or corporation to whom or to which the Contractor has, pursuant to GC18., sub-contracted any portion of the Work.

1.1.10 "Superintendent" means the employee of the Contractor who is designated by the Contractor to act pursuant to GC7.2.

1.1.11 "Work" includes, subject only to any express stipulation in the contract to the contrary, everything that is necessary to be done, furnished or delivered by the Contractor to perform the Contract.

GC2. CONTRACT DOCUMENTS

2.1 The several documents forming the contract shall be taken as mutually explanatory of one another and in the case of ambiguities, discrepancies or conflicts the same shall be explained and adjusted by the Purchaser in accordance with the priority set out in Articles of Agreement A.1.1.

2.2 The Plans, Specifications and associated documents shall, as to the content, remain the sole property of the Purchaser and shall not be used by the Contractor for the construction of another project. In addition to the signed contract documents set out in GC2.5 the Purchaser shall furnish to the Contractor without charge to him, as many copies of all plans and specifications as are reasonably necessary for the proper execution of the Work. The Purchaser shall have authority to supply to the Contractor from time to time during the progress of the Work such further additional or substitutional drawings and information as in his opinion may be necessary or desirable for the purpose of the proper and adequate execution and maintenance of the Work and the Contractor shall construct the Work according to such plans and information.

2.3 Any shop plans or drawings, working plans or drawings, or other drawings which under the Contract, the Contractor is required to provide, shall be submitted to the Purchaser for his review.

2.4 During the continuance of the Contract, the Contractor shall keep on the site one set of all Plans and Specifications pertaining to the Contract. Such Plans and Specifications shall be available at all reasonable times for the inspection and use of the Purchaser.

2.5 The Contractor shall not use scaled dimensions for the construction of the Work. Should any dimensions be unobtainable from the Plans, the Contractor shall obtain them in writing from the Purchaser.

GC3. KNOWLEDGE OF SITE

3.1 The Contractor shall be deemed to have inspected and examined the site and its surroundings and to have satisfied himself as to the nature of the ground and subsoil, the form and nature of the Site, the quantities and nature of the Work, materials necessary for the completion of the Work, the means of access to the Site, the accommodation which he may require and, in general, to have obtained all necessary information as to the proposed Work and as to any risks, contingencies and other circumstances affecting his performance of the Contract.

3.2 No plea of ignorance of conditions that existed at the time of agreement or that may have thereafter existed or of conditions or difficulties that may have been encountered in the execution of the Work under the Contract as a result of failure to make the necessary examination and investigations will be accepted as an excuse or any failure or omission on the part of the Contract, or will be accepted as a basis for any claims whatsoever for extra compensation or an extension of time.

3.3 The Contractor shall be deemed to have satisfied himself before execution of the Agreement as to the correctness and sufficiency of his tender and the price he has agreed to shall be deemed to cover and include all his obligations under the Contract.

GC4. EXTENT OF CONTRACT

4.1 The Contract comprises the construction and completion, of the Work as shown on the Plans and described in the Specifications and the provision of all labour, materials, construction and other equipment, temporary work, and everything, whether of temporary or permanent nature, required in and for such construction, completion, and testing so far as the requirement for providing the same is specified in, or reasonably to be inferred from the Contract.

4.2 It is the intention to provide for a finished piece of Work, complete in all essentials, including all items reasonably inferrible from the Plans and Specifications notwithstanding that every item necessarily involved may not be particularly mentioned. The contractor shall not take advantage, to the detriment of the Purchaser, of any error or omission should such exist and shall bring to the attention of the Purchaser any such discrepancies. Where the quality of workmanship or materials is not specifically stated, the best quality shall be provided.

GC5. SECURITY

5.1 The Contractor shall provide security within fourteen (14) days of acceptance of its tender. The surety shall be as stated herein.

5.2 The Contractor shall deliver to the Purchaser or as otherwise instructed a Performance Bond and a Labour and Materials Payment bond in a form and issued by a bonding or surety company that is acceptable to the Purchaser.

5.3 Each bond shall be in the amount of 50% of the Price as set out in A.7, of the Articles of Agreement. Should the final cost of the project exceed the Price by more that 10% as a result of changes in the Work pursuant to GC31. herein, the Contractor shall arrange to have his bonds reissued, based on the projected final cost.

5.4 In lieu of Performance Bond, the Purchaser may accept at its discretion other readily realized deposits such as certified cheques or Bearer Bonds having a present day worth amounting to 20% of the contract Price.

GC6. MANAGEMENT OF CONSTRUCTION

6.1 By notice given the Contractor pursuant to GC13, Minas Basin Pulp and Power shall designate a Purchaser Representative for the purposes of the Contract. The term "Purchaser" as defined in GC1 and as used herein refers to MBP&P or the Purchaser Representative.

6.2 The execution of the Work shall be carried out in all its several parts in such a manner and at such places to the complete approval of the Purchaser.

6.3 When and as often as the Purchaser is not satisfied with the work done or being done under this Contract, or with the kind of quality of the material and equipment supplied or being supplied thereunder, he may give notice of his dissatisfaction to the Contractor in writing and the Contractor shall immediately, upon receipt of such notice, reconstruct the said work and repair or replace the said material and equipment all in the manner prescribed by, and to the approval of the Purchaser. All such reconstruction, replacement and repair shall be done at the expense of the Contractor.

6.4 The Contractor shall:

6.4.1 furnish the Purchaser with such information respecting its performance of the Contract as he may require; give the Purchaser every possible assistance to enable the Purchaser to carry out his duty to see that the Work is performed in accordance with the Contract and to carry out any other duties and exercise any powers specially imposed or conferred on the Purchaser under the Contract; and in

particular, but not so as to restrict the generality of the foregoing, the Contractor shall at all times during the term of the Contract co-ordinate its performance thereof with the activities of the Purchaser contemplated herein.

6.4.2 give the Purchaser every possible assistance to enable the Purchaser to carry out his duty to see that the Work is performed in accordance with the Contract and to carry out any other duties and exercise any powers specially imposed or conferred on the Purchaser under the Contract; and in particular, but not so as to restrict the generality of the foregoing, the Contractor shall at all times during the term of the Contract co-ordinate its performance thereof with the activities of the Purchaser contemplated herein.

6.5 The fact that the Purchaser has not disapproved of, or rejected any part or parts of the Work or any of the Equipment supplied in connection therewith at the time of making any Progress Estimate in accordance with GC37 or at any other time during the continuance of this Contract shall not be construed to be an acceptance of any such part or parts of the Work or any such Equipment.

GC7. LABOUR FORCE - CONTRACTOR'S RESPONSIBILITIES

7.1 The Contractor shall, to ensure the proper and efficient performance of the Contract, provide the labour necessary to complete the Contract all in accordance with the Labour Conditions, made pursuant to the Fair Wages and Hours of Labour Act. The revised Labour Conditions are attached in Appendix 1.

7.2 The Contractor shall, at all times during the continuance of the Contract, keep in full-time employment on the site a competent superintendent who shall be fully empowered to act for and on behalf of and to bind the Contractor in all matters pertaining to the Contract, any explanation, order, direction or request given to the said agent shall be deemed to have been given to the Contractor.

7.3 The superintendent or agent shall, if the Purchaser so requires, be solely employed upon work directly connected with the Contract.

7.4 The Contractor shall, upon the request of the Purchaser, remove any superintendent who, in the opinion of the Purchaser, is incompetent or has been conducting himself improperly and shall forthwith designate another superintendent who is acceptable to the Purchaser.

7.5 Subject to 7.4, the Contractor shall not substitute a superintendent or any of this assistants without the written consent of the Purchaser.

7.6 A breach by the Contractor of 7.5 shall entitle the Purchaser to refuse to issue any certificate referred to in the Contract, until the superintendent has returned to the work site or another superintendent who is acceptable to the Purchaser has been substituted.

7.7 The Contractor shall forthwith supply to the Purchaser an organization chart, setting out the names and responsibilities of each of its employees. The Contractor shall, if in the opinion of the Purchaser the work warrants it, supplement the workforce by additional force, overtime work or night work and/or replace existing Contractor's employees, so as to ensure proper, timely and efficient execution of the Work; IT BEING UNDERSTOOD AND AGREED that, notwithstanding anything herein contained to the contrary, the Contractor shall hire only such quantities of labour as may be required in the opinion of the Purchaser for the purposes of this Contract.

7.8 The Contractor shall not hire employees of the Purchaser, or other Contractors or their subcontractors employed on the work site without the written release from such employer.

7.9 The Contractor shall make every effort to avoid and eliminate all work stoppages and labour disputes including union "jurisdictional" disputes. The Contractor shall supply the Purchaser with a copy of each of its collective agreement(s) which may be relevant to work on the project site, and shall advise the Purchaser on a regular basis of the state of all labour relations matters.

7.10 Settlement of any and all labour disputes including "jurisdictional" disputes shall in no way alter the terms of the Contract.

GC8. UNSUITABLE PERSONNEL

8.1 The Contractor shall, upon the request of the Purchaser, remove any person employed by it for purposes of the Contract who, in the opinion of the Purchaser, is incompetent or has conducted himself improperly, and the Contractor shall not permit a person who has been removed to return to the work site.

GC9. CANADIAN LABOUR AND MATERIAL

9.1 The Contractor shall use Canadian labour and material in the performance of the Work, to the fullest extent practicable.

GC10. INTERPRETATION OF CONTRACT BY PURCHASER

10.1 If, at any time before the Purchaser has issued a Certificate of Completion referred to in GC29, any question arises between the parties about whether anything has been done as required by the Contract or about what the Contractor is required by the Contract to do, and, in particular but without limiting the generality of the foregoing, about

10.1.1 whether or not the quality or quantity of any workmanship supplied or proposed to be supplied by the Contractor meets the requirements of the Contract,

10.1.2 whether or not the labour, plant and material provided by the Contractor for performing the Work and carrying out the Contract are adequate to ensure that the Work will be performed in accordance with the Contract and that the Contract will be carried cut in accordance with its terms,

10.1.3 what quantity of any kind of Work has been completed by the Contractor, or

10.1.4 the timing and scheduling of the performance of the Work pursuant to the construction schedule required in GC35.2.

then the Contractor shall perform the Work in accordance with any decision of the Purchaser who shall have full authority to arbitrate any such question, and in accordance with any consequential directions given by the Purchaser.

10.2 Should the Contractor hold any such decision to be at variance with the Contract documents, or to involve changes in Work already built, fixed, ordered or in hand in excess of the Contract, or to be given in error, he shall notify the Purchaser in writing before proceeding with any such changes.

GC11. VERBAL ARRANGEMENTS

11.1 In all cases of misunderstanding and disputes, verbal arrangements will not be considered, but the Contractor must produce written authority in support of his contentions, and shall advance no claim in the absence of such written authority, or use, or attempt to use, any conversation with any parties against the Purchaser.

GC12. EXTENSION OF TIME

12.1 The Contractor shall immediately notify the Purchaser, in writing, of any occurrence which, in the opinion of the Contractor, has caused or which he anticipates may cause a substantial delay which will affect the performance of the Work according to the Construction

Schedule or the completion date for the entire Work, and in any event shall notify the Purchaser, in writing, not later than seven (7) days after the occurrence which caused the alleged delay or gave rise to the anticipated delay.

12.2 In addition to submitting the above notice, if the Contractor claims that the alleged delay was occasioned through labour disputes, strikes, lock-outs, fire, unusual delay by common carriers or unavoidable casualties, or by any cause of any kind whatsoever beyond the Contractor's control, then he may also submit an application to the Purchaser for a revision of the Construction Schedule and for an extension of the time for completing the Work, and at no extra cost to the Purchaser.

12.3 If the Contractor considers that the alleged delay was the direct result of the act or neglect of the Purchaser, then the Contractor may also submit a written application to the Purchaser for approval to the reimbursement of the Contractor's additional field overhead costs which can be shown to be the result of the delay due to such act or neglect. No such costs shall be deemed to have been incurred by the Contractor due to the regularly scheduled holiday shutdowns of the Purchaser's plant and operations, as set forth in the Purchaser's effective agreement with the Canadian Paperworkers Union.

12.4 No claim for extension of time shall be allowed on account of failure to furnish plans or drawings until 2 weeks after demand for such plans or drawings and not then unless such claim be reasonable.

An application referred to in GC12.2 shall be accompanied by the written consent of the bonding company whose bonds form part of the Contract security.

GC13. NOTICES

13.1 Any notice to be given to the Contractor under the Contract shall be served by sending the same by mail to or leaving the same at the Contractor's principal place of business as specified in the Articles of Agreement but the Purchaser's written orders shall be deemed to be properly delivered if sent by mail to or left at the site office of the superintendent.

13.2 Where the postal service is disrupted by a strike, a notice hereunder may be given by telex or telegram and shall be deemed to have been received twenty-four hours after it was transmitted.

GC14. PURCHASER'S PROPERTY

14.1 All material and plant, real property, licenses, powers and privileges acquired, used or provided for the Work shall, from the time of their acquisition, use or provision, be the property of the Purchaser for all purposes, and they shall continue to be the property of the Purchaser.

14.2 Material or plant that is the property of the Purchaser by virtue of 14.1 shall not be taken away from the work site or used or disposed of except for the purposes of the Work.

14.3 To the extent that circumstances allow, the Contractor shall protect the Work and its site, and protect the Contract, specifications, plans, drawings, information, material, plant and real property, whether or not they are supplied by the Purchaser to the Contractor, against loss or damage from any cause, and shall not use, issue, disclose or dispose of them without the written consent of the Purchaser, except as may be essential for the performance of the Work.

14.4 If any document or information given or disclosed to the Contractor is assigned a security rating by the person who gave or disclosed it, the Contractor shall take all measures directed by the Purchaser to be taken to ensure the maintenance of the degree of security that is ascribed to that rating.

14.5 The Purchaser shall provide all facilities necessary in its opinion for the purpose of maintaining security, and the Contractor shall assist any person authorized by the Purchaser to inspect or to take security means in respect of the Work and its site; PROVIDED that the Purchaser may direct the Contractor to do such things and to perform such additional Work as the Purchaser considers reasonable and necessary to ensure compliance with or to remedy a breach by the Contractor of this paragraph.

14.6 The Purchaser shall have the right to take possession of and use any completed or partially completed portion of the Work notwithstanding that the period of time for completing the Work, or such portion thereof, may not have expired. Such taking possession of the use shall not be deemed an acceptance of any of the Work not carried out in accordance with the Contract Documents.

GC15. PROTECTION OF PROPERTY

15.1 Subject to 15.2 the Contractor is liable to the Purchaser for any loss of or damage to material, plant or real property referred to in 14.1 and 14.3, and any liquidated damages arising from such loss or damage to material, plant or real property, and/or that is supplied or placed in the care, custody and control of the Contractor by the Purchaser for use in connection with the Contract, where said loss or damage is attributable to the Contractor's negligence or carelessness of any of the Contractor's negligence or carelessness of any of the Contractor's employees, agents or invitees. The Contractor shall repair and make good the damage so that at the completion of the Work the same is in good condition.

15.2 The Contractor is not liable to the Purchaser for any loss or damage referred to in 15.1 if that loss or damage results from and is directly attributable to reasonable wear and tear.

15.3 The Contractor shall not use any material, plant or real property referred to in 15.1 except for the purpose of performing this Contract.

15.4 When the Contractor fails to make good any loss or damage for which it is liable under 15.1 within a reasonable time after being required to do so by the

Purchaser, the Purchaser may cause the loss or damage to be made good at the Contractor's expense, and the Contractor shall thereupon be liable to the Purchaser for the cost thereof, and the Purchaser shall be entitled to deduct such cost from the amounts payable to the Contractor under the Contract.

15.5 The Contractor shall keep such records of all materials, plant and real property referred to in 15.1 as the Purchaser from time to time required and shall satisfy the Purchaser, when requested, that such material, plant and real property are at the place and in the condition in which they ought to be.

GC16. CLEAN UP OF THE SITE

16.1 The contractor shall, at all times, keep the site free from accumulations of waste material and debris which arise out of the performance of the Work, and at the completion of the Work, he shall remove all his rubbish and all tools, equipment, temporary buildings, rubbish and surplus materials from and about the Work, and shall leave the Work "broom clean". In particular without limiting the generality of the foregoing the Contractor shall keep the site, the Work of other contractors free from dropping, dripping and spattering of materials used in the Work. This obligation does not extend to waste material and other debris caused by the Purchaser's servants or other contractors.

16.2 The Contractor shall exercise particular care to prevent concrete, mortar, plaster, paint or other materials from entering or damaging the sewers and other parts of the drainage system or other components of the total system and shall satisfy the Purchaser, that no such materials and lodged therein, or shall remove same as directed.

16.3 The Purchaser retains the right to direct the disposal of waste or scrap generated during the Work to locations on its property.

16.4 If at any time the Contractor has substantially completed the Work, including removal of temporary buildings and equipment, the weather conditions are such that, in the opinion of the Purchaser, it is impracticable for the Contractor to carry out the remainder of the cleaning up operations effectively, or are such as to make it impossible for the Purchaser to properly inspect the conditions of the Site, then the Purchaser may retain from payments due to the Contractor any amount sufficient to cover the cost of such cleaning up.

16.5 In case of a dispute between the parties, which prevents the Contractor from performance of its obligations under GC16.1, the Purchaser may perform such obligations and charge the cost as the Purchaser shall determine to be just.

GC17. COOPERATION WITH OTHER CONTRACTORS

17.1 Where in the opinion of the Purchaser, it is necessary that the Purchaser's own employees, other contractors or workers with or without plant and material, be sent onto the site, the Contractor shall, to the satisfaction of the Purchaser, co-operate with them in carrying out their duties and obligations.

17.2 The Contractor shall afford the Purchaser's own employees, or Other Contractors reasonable opportunity for the introduction and storage of their materials and the execution of other work. It shall work in conjunction with the Purchaser and Other Contractors to coordinate and connect properly the several parts of the Work. It shall not commit or permit any act which will interfere with the performance of other work of the Other Contractors.

17.3 Where the Contractor's Work adjoins other work of Other Contractors, he shall confer with them as required and so arrange his Work that there shall be no discrepancies when the whole work is completed.

17.4 If the Contractor fails to cooperate with or coordinate the Work with other work of Other Contractors, he shall not make any claims founded on delays which have resulted from such failure and he shall save the Purchaser harmless from all claims made by Other Contractors, which are founded on delays caused by such failure.

17.5 If any part of the Work depends for its proper execution or result upon other work of Other Contractors, the Contractor shall report promptly in writing to the Purchaser any defects in other work of such Other Contractors that interfere with the proper execution of the Work.

17.6 Copies of plans, drawings and specifications relating to another contract will be furnished to the Contractor on request, for his information in carrying out the above provisions. The Contractor shall be responsible for any and all damages caused by his negligence or failure to co-ordinate his Work with that of the Purchaser or Other Contractors and any additional expenses arising therefrom.

GC18. SUBCONTRACTING

18.1 The Contractor shall not sub-contract the Contract or any part thereof or any benefit or interest therein unless, before signing of the Contract, he has notified the Purchaser in writing of the names of the Sub-contractors proposed and the parts of the Work they are to perform, and the Purchaser has given its written consent prior to the signing of the Contract. The Contractor shall not employ any Sub-Contractors to whom the Purchaser may reasonably object.

18.2 In sub-contracting for any part of the Work, the Contractor shall make a contract with the Sub-Contractor wherein the latter shall expressly agree to be bound by the terms of this Contract, including these General Conditions, and the plans, drawings and the specifications insofar as they are applicable, and the Contractor shall exact from every Sub-Contractor strict compliance therewith. The Sub-Contractor shall be responsible to the Contractor for unsatisfactory Work and for damage done in removing and replacing defective work or materials and for other damage done by them or their employees.

18.3 The Contractor alone shall be fully liable to the Purchaser for the acts and omissions of his Sub-Contractor and of persons employed by them, and the consent of the Purchaser to sub-contract shall not relieve the Contractor from any liability or obligation under the contract. Contractor shall not be obliged to employ as a Sub-Contractor any person or firm to whom he reasonably objects.

18.4 Plans and drawings from a Sub-Contractor shall be approved by the Contractor before delivery to the Purchaser for review.

18.5 The Corporation reserves the right, at any time during the construction period, to have the Contractor remove from the job and the Site any Sub-Contractor whose work does not meet with the Purchaser's approval.

GC19. INSURANCE

19.1 The Contractor and/or Sub-Contractor shall arrange his own protection in respect of Worker's Compensation Benefits, and such other insurance involving the use of licensed motor vehicles, or his Contractor's Equipment or Tools, or any other general matters, as he considers expedient and, for this purpose, shall (without limiting its liability or any indemnification or hold harmless provision in his Contract) at its own expense purchase and maintain the following:-

(i) Worker's Compensation coverage in accordance with the requirements of the Province in which the work is being carried out. Proof of good standing with the respective Worker's Compensation Board must be furnished before start of work and also before application for final payment.

(ii) Automobile Liability Insurance on all vehicles owned, non-owned, and/or hired by the Contractor and/or Sub-Contractor, with a minimum inclusive limit of $5,000,000 (five million dollars). Evidence of this Insurance having been effected must be furnished before start of Work.

(iii) Insurance on Contractor's Equipment or Tools on a "Replacement Cost" basis. A waiver or subrogation in favor of the Purchaser must be provided. Evidence of this Insurance having been effected must be furnished before start of Work. Indicate this cost as a separate item on the Tender.

19.2 At the option of the Purchaser The Contractor shall arrange a Comprehensive Insurance Programme to cover the interests of the Purchaser, Consultants, and the Contractor and his Sub-Contractors engaged in this project. It will be necessary, therefore, for a Contractor to purchase insurance against the perils covered by such a Comprehensive Insurance programme and to indicate this cost as a separate item on the tender. The Contractor and/or Sub-Contractor shall be responsible for payment of any deductibles forming part of the Programme. The policies shall include a clause making them primary insurances regardless of whether the Purchaser has insurance which might cover the loss. The protection provided shall be as follows:

(i) Insurance against essentially ALL RISKS of physical loss or damage to the project including any material or property going into the project, and located anywhere in transit, or on the job site awaiting or during construction, or installation, or testing, until such time as the project is accepted by the Purchaser, or the Insurance is terminated for any cause, whichever first occurs.

(ii) "Comprehensive Third Party Liability" Insurance providing indemnity for each Insured for injury to persons (other than his own employees), and damage to property of others (other than his leased property), or property in his care, custody or control, ARISING DURING THE CONSTRUCTION PERIOD, and until such time as the project is accepted by the Purchaser, or the Insurance is terminated for any cause, whichever first occurs. The Insurer's Liability is limited to $5,000,000.00 in respect of any injury claim, or a damage claim, or a combination of both.

(iii) The insurance described in 19.2 (i) and 19.2 (ii) shall be specifically subject, but not limited to, the following: -

1. Be written on an "Occurrence" basis.
2. Including Personal Injuries coverage.
3. Including Contingent Employer's Liability Protection.
4. Including liability assumed under this contract.
5. Sixty days written notice to be given prior to cancellation of any material change in the policy.
6. 24 months completed operations coverage.

7. Employees as Additional Named Insured.
8. Non-owned automobiles.
9. Cross liability clause.
10. Protective liability.

19.3 The Contractor shall be responsible to notify the Purchaser and Sub-Contractors engaged in the project, if the Insurance is terminated prior to acceptance of the project.

19.4 Any loss recoverable under the Insurance described in paragraph 19.2 (i) shall be payable to the Contractor. The Purchaser and Sub-Contractors shall assist the Contractor and cooperate fully in the processing and adjustments of claims with the Insurance Underwriters as soon as is reasonably practical or at least upon completion of any such adjustment, the Contractor/Sub-Contractor shall repair the damage, and/or replace the loss, and complete the work. Such damage or loss shall not affect the rights and obligations of either party under the Contract except that in such an event, the Contractor/Sub-Contractor shall be entitled to such reasonable extension of time for the performance of the Work as the Purchaser may decide.

19.5 "Certificate of Insurance" shall be supplied by the Contractor to the Purchaser on forms as issued by the Contractor's Insurance Underwriters or the latter's authorized representative. No other forms will be used, and no change will be made thereto.

GC20. CONTRACTOR SAFETY AND LOSS CONTROL

20.1 The Contractor shall make every effort to reduce the potential for accidental injury and/or damage resulting from the Contractor's activities while on the Purchaser premises.

20.2 The Contractor shall implement a safety program which shall include the procedures outlined herein in order to reduce the potential of loss for injury or damage caused by accidents in connection with the performance of the Work. The Contractor shall designate a responsible member or members of its organization at the site whose duty shall include the coordination of such safety, security and fire control measures. The name of the person or persons designated shall be transmitted in writing by the Contractor to the Purchaser prior to the contractor starting work on the Purchaser's site.

20.3 Contractor shall ensure that its employees, agents and invitees, and its sub-contractors and their employees, agents and invitees, while on the Purchaser's premises, comply with all applicable safety laws, rules and regulations and Purchaser's safety regulations, as issued from time to time, and with all directions by the Purchaser regarding protective clothing, head covering, eye and ear protection. The Purchaser on request shall supply to Contractor a copy of the Purchaser's applicable regulations.

20.4 the safety of all persons employed by Contractor or his sub-contractors or the agents or invitees of Contractor or his sub-contractors or any other person who enters the project site for any purpose relating to Contractor's carrying out his obligations hereunder shall be the full responsibility of the Contractor. The Contractor shall notify the Purchaser, in writing, of the existence of any hazardous conditions, property or equipment at the work site which are not under the Contractor's control; however, it shall be Contractor's responsibility to take all necessary precautions against injury to such persons or damage to the property of the Contractor, his sub-contractors or such persons, from such hazards until corrected by the responsible party.

20.5 The Contractor shall confine all persons employed by the Contractor or his sub-contractors or his agents or invitees of the Contractor or his sub-contractors or any other person who enters the project site for any purpose relating to the Contractor's carrying out his obligations hereunder to that portion of the project site where the work under this contract is to be performed, to the routes to be designated by the Purchaser for ingress and egress thereto and to any other areas the Purchaser may expressly permit the Contractor to use. Within such areas, except those routes for ingress and egress over which the Contractor has no right to control, the Contractor shall provide safe means of access to all places at which any such person may at any time have occasion to be present.

20.6 Explosives shall be stored and handled as required by the Safety Regulations governing the storage, handling, preparing and firing of explosives. Where blasting is required, the Contractor shall take all necessary precautions to protect existing facilities and persons from injury. Extreme care shall be taken to prevent rocks and other material from being blasted out of excavations into the surrounding area. The Contractor shall take whatever precautions are necessary to protect against premature discharge of electric detonators due to radio transmitters in the vicinity, electrical storms, and/or stray electric fields and currents.

20.7 The Contractor shall take all reasonable measure to prevent injury to all persons or damage to any property on the Purchaser's premises, or in the vicinity thereof, as a result of the Contractor's performing work, whether or not a hazard or potentially hazardous condition exists due to the sole prosecution of the Contractor's work or due to same in conjunction with other work or activity being performed by the Authority of others. Should the Purchaser request that the Contractor provide certain safeguards required for the protection of persons or property and should the Contractor fail to comply with such request within a reasonable time, the Purchaser will regard such failure as a breach of the Contractor's obligations under the Contract.

20.8 The Contractor shall make his own arrangements to supply first aid to anyone acting for him who may be injured in connection with the Work, subject only to an alternate arrangement between the Contractor and the Purchaser.

20.9 The Contractor shall ensure that adequate, approved fire extinguishing equipment in good working condition shall be readily available on the site, particularly but not to limit the generality of the foregoing fire extinguishing equipment should be available where any welding, flame cutting or heating operation is being performed.

20.10 The Contractor shall indemnify and save harmless the Purchaser from any liability for injury to persons or damage to property arising out of any breach by the Contractor or his sub-contractors (or by the employees, agents or invitees of the Contractor or his sub-contractors, or by any other person who enters the project site for any purpose related to the Contractor's carrying out of his obligations hereunder) of the Purchaser's safety, security and fire protection policies.

GC21. LAW OF CONTRACT

21.1 This Agreement shall be deemed to have been made in Nova Scotia and shall be performed exclusively in Nova Scotia, and the Laws of the Province of Nova Scotia (and the Laws of Canada, where applicable) shall govern the interpretation of this Agreement and the rights and obligations of the parties hereunder. Any action, suit or proceeding which may be instituted, brought or prosecuted hereunder by either party shall be so instituted, brought or prosecuted in the appropriate court in Nova Scotia.

GC22. NO WAIVER

22.1 Unless a waiver is expressly given in writing, neither party shall be deemed to have waived any breach hereof by the other; and any waiver so given shall relate solely to the specific breach to which it refers.

GC23. NOTIFICATION OF REGULATORY AGENCIES

23.1 The Contractor shall be responsible for fully complying with the requirements of all regulatory agencies having jurisdiction over all or any part of the Work under this Contract. These requirements may affect construction methods and may include written notification of the appropriate authority prior to the commencement of Work. Where written notification of any agency or authority is required, a copy of the said notification shall be submitted to Purchaser.

23.2 The Contractor shall be responsible for obtaining at his expense all permits required for the construction of the Work, except those permits for which the Purchaser only may apply, such as a Department of Highways work permit.

23.3 The Contractor shall fully familiarize himself with the conditions of all permits, whether obtained by the Purchaser or himself and shall assume the defense of and indemnify and save harmless the Purchaser and its officers and agents from whatsoever claim arising from the Contractor's failure to observe any conditions of said permits.

GC24. ENVIRONMENTAL LAWS

24.1 The Contractor shall be responsible for fully complying with all Environmental Laws, both federal and provincial, which apply to all or any part of the Work under this Contract. These requirements may affect construction methods and may include written notification of the appropriate authority prior to the commencement of Work.

GC25. PATENT RIGHTS, ROYALTIES AND RESTRICTIONS

25.1 The Contractor shall save harmless and indemnify the Purchaser from and against all claims and proceedings for infringement of any patent rights, designs, trademark, or name, or other protected rights in respect of any Equipment, Construction Equipment and work which the Contractor provides in connection with any temporary work or with the permanent work.

GC26. PUBLIC CEREMONIES AND SIGNS

26.1 The Contractor shall not permit any public ceremony in connection with the Work without the prior written consent of the Purchaser. The Contractor shall not erect or permit the erection of any sign or advertising on the Work or its site without the prior written consent of the Purchaser.

GC27. HANDLING AND STORAGE OF EQUIPMENT AND MATERIAL

27.1 The Contractor shall, at his own expense, receive and check, off-load, handle on the Site and store in areas to be designated by the Purchaser, all equipment and material supplied by the Contractor for the Work which arrives on the Site during the time the Contractor is to be on the Site, according to the Construction Schedule.

27.2 If equipment or material that the Contractor is responsible for receiving and checking, off-loading, handling and storing is off-loaded, handled or stored by the Purchaser, the expense incurred shall be payable by the Contractor on demand or may be deducted by the Purchaser from money due to the Contractor.

27.3 The Contractor shall take all appropriate precautions against loss, theft or damage of equipment or material delivered to the Site for the purpose of the Work, whether such equipment or material is the property of the Purchaser, the Contractor, Sub-Contractor or others.

27.4 The Contractor shall be completely responsible for the safekeeping for all of his tools and equipment and for those of his employees while on the Site and shall provide all the necessary facilities and services for such safekeeping. The Purchaser will not accept any claims from the Contractor or Sub-Contractor for the loss or damage of such tools and equipment.

27.5 No tools, equipment, material or other articles may be removed from the Site, unless the person removing such article can clearly identify each article and establish his ownership and his right to remove it from the Site.

27.6 The Purchaser will assign to the Contractor a specific storage area near the place of building.

27.7 All materials which will become a permanent part of the Work shall be stored in a manner which will preserve their original conditions and fitness for the Work. Materials requiring indoor or special storage, or preparation for storage, shall be so prepared and stored. The manufacturers instructions for storage and handling of his products shall be followed in full.

GC28. PROVISIONAL CERTIFICATE OF COMPLETION

28.1 28.1.1 As soon as, in the opinion of the Purchaser, the works have been substantially completed and have satisfactorily passed any final tests required under the Contract and the Contractor has given the Purchaser the documents listed in 28.1.2 the Purchaser may issue a Provisional Certificate of Completion.

28.1.2 The Contractor shall submit the following documents pursuant to GC28.1.1:-

(1) A statutory declaration to the effect that all expenses incurred by him in carrying out the Contract have been paid and releasing the Purchaser from any and all further claims relating to the Contract.

(11) A certificate from the Registrar of deeds stating that there are no Mechanics Liens filed relating to the Contract Works.

(111) A clearance certificate from the Workmen's Compensation Board.

(iv) A written undertaking to complete any outstanding work and to discharge all unfulfilled obligations under the Contract.

(v) Written warranties from the Contractor's sub-contractors in accordance with GC30.4.

28.2 If, through no fault of his own, the Contractor is unable to complete the work or should the Purchaser request that the completion of certain portions of the work be temporarily delayed, then the Purchaser may issue the Provisional Certificate of Completion for such works that have been substantially completed, provided that he retains sufficient monies in accordance with the provisions of this Contract. Any release of monies under this General Condition shall be made pursuant to GC37 Payment.

GC29. CERTIFICATE OF COMPLETION

29.1 On the date that

29.1.1 the Work has been completed, and

29.1.2 the Contractor has complied with the Contract and all others and directions made pursuant thereto, to the satisfaction of the Purchaser, the Purchaser shall issue a Final Certificate of Completion to the Contractor.

29.2 The Contractor may be required to provide to the Purchaser the documents listed in GC28.1.2 before the Certificate of Completion is issued.

29.3 The issuance by the Purchaser of the certificate and the acceptance by the Contractor of the amount or amounts certified for payment thereunder, shall constitute a waiver and release by the Contractor under the Contract, except only those claims, if any, stipulated in the certificate as being unsettled.

GC30. WARRANTY AND RECTIFICATION OF DEFECTS IN WORK

30.1 Without restricting any warranty or guarantee implied or imposed by law or elsewhere contained in the contract documents, the Contractor shall, at his own expense, rectify and make good any defect or fault that appears in the Work or comes to the attention of the Purchaser within 12 months from the date of the Certificate of Completion referred to in GC29 or within such longer period as may be stipulated elsewhere in the Contract. The Contractor shall indemnify the Purchaser for any damage resulting therefrom which appears within such a period of time.

30.2 A direction referred to in GC30.1 shall be in writing, may include a stipulation in respect of the time within which a defect or fault is required to be rectified and made good by the Contractor, and shall be given to the Contractor in accordance with GC13.

30.3 The Contractor shall rectify and make good any defect or fault described in a direction given pursuant to GC30.1 within the time stipulated therein.

30.4 The Contractor shall secure from its Sub-Contractor and Vendors of equipment or materials written warranties in conformity with the foregoing and shall transmit same to the Purchaser prior to presentation of his claim for final payment.

30.5 The Purchaser shall give notice of observed defects with reasonable promptness. Neither inspection or approval of any samples or any part of the Work, nor final acceptance of the Work, nor any payment by the Purchaser shall relieve the Contractor of responsibility for faulty materials or workmanship.

GC31. CHANGES IN THE WORK

31.1 The Purchaser may order any change of the form, quality, or quantity of the Work. Upon receipt of written instructions from the Purchaser, the Contractor shall make the required change.

31.2 No such variation or change shall be made by the Contractor without first obtaining written instruction from the Purchaser, which instructions shall provide the authority to perform the same, the details of the Work to be performed, and the amount or basis on which the Contractor will be paid for the same.

31.3 All the provisions of this Contract shall apply to any variation ordered by the Purchaser to the same extent as to the Work described in the Contract.

31.4 Any claim for an extension of time in regard to the Construction Schedule or the completion date shall be dealt with pursuant to GC12 Extension of Time at the time such changes are ordered.

31.5 If the Purchaser decides that a change in the Work shortens the period required for completion of the Work, he shall so notify the Contractor and state the number of days by which such period is to be shortened, and the Construction Schedule or the completion date or both, shall be amended accordingly by the Contractor.

31.6 If a change in the Work, or any other circumstances arising during the course of the Work, except those provided for in Article GC12 Extension of Time, justifies, in the opinion of the Contractor, a claim for an addition to the Contract Price, the Contractor shall present his claim in writing to the Purchaser within Seven (7) days of the date of receiving the order for the change, or the drawing showing the change, or of the date on which such other circumstances arise, and if the claim is not presented to the Purchaser within such time, the Contractor shall not be entitled to compensation from the Purchaser. Upon receipt of such a claim the Purchaser will decide whether the claim is valid and the basis and amount of payment, if any, pursuant to GC32.

31.7 If the Purchaser decides that a change in the Work results in a decrease in the cost of carrying out the Work, the Purchaser shall decide the amount that is to be deducted from the Contract price. In such event the Contractor shall not be entitled to nay compensation for loss of anticipated profits.

31.8 If the Contractor disputes a decision of the Purchaser as to whether a change in the Work will result in an addition to or deduction from the Contract Sum, the Contractor shall nonetheless perform the Work but shall give the Purchaser, before commencing the Work, a further written notice that he is performing the disputed Work under protest.

31.9 All claims resulting from changes in the Work submitted by the Contractor shall be accompanied by a list of the changes and a detailed estimate of the cost of each change, together with reference to the plans, drawings or other documents involved.

GC32 VALUATION OF CHANGES IN THE WORK

32.1 The Purchaser shall determine the amount, if any, to be added to or deducted from the Contract Price in respect of any additional Work done, or Work omitted by his order. All such Work shall be valued on a lump sum basis in one or more of the following ways:-

32.1.1 By the application of Unit Price as Set Out in The Articles of Agreement

32.1.2 By The Application of Unit Prices Agreed Upon

32.1.3 By Estimate and Acceptance in a Lump Sum Pursuant to GC31.9

32.2 If a lump sum for payment cannot be agreed upon, the change in the Work shall be carried out on a cost reimburseable basis, as follows:-

32.2.1 For labourers, tradesmen and foremen wholly engaged on the Change in the Work, the Contractor shall receive the current local rate of wages, the cost of vacation pay, Workmen's Compensation Insurance, Unemployment Insurance, and any other labour additives required by law, excluding premium wages for overtime work.

32.2.2 For any construction equipment (other than tools) required for the Change in the Work, approved by the Purchaser, the Contractor shall receive a rental price to be approved in writing by the Purchaser before the Work is begun. Such rental price, unless otherwise stipulated, shall include at the expense of the Contractor, the supply of the operator, fuel, lubricants, supplies, spare parts and repairs and shall apply only to actual operating time. No percentages shall be added to this rental sum.

32.2.3 Tools shall include all tools and items of equipment which have individual replacement values under $1,000. Construction Equipment shall include all items of equipment having an individual replacement value of $1,000 or more.

32.2.4 At the end of each day the Contractor shall submit in duplicate to the Purchaser for certification a list of the men and construction equipment employed on the Change in the Work and the hours worked, together with invoices for any materials used during the day. These daily certified lists and invoices shall be submitted to the Purchaser with the relevant application for payment.

32.2.5 For materials or sub-contacted work purchased by the Contractor and actually used in the Change in the Work, the Contractor shall receive the actual cost of such materials including transportation charges, and of such sub-contracted work, as shown by invoices or other records of payment satisfactory to the Purchaser.

32.2.6 To the labour, materials and sub-contract costs as specified in GC32.2, shall be added the percentages for labour, material and sub-contracted work respectively, set forth in the Articles of Agreement to cover profit, general supervision, overhead, tools and other general expenses.

32.2.7 For living allowances and cost of board and lodging for employees wholly engaged on the Change in the Work, and other costs not included above which form part of such employees' terms of employment, the Contractor shall receive that portion of the actual cost of such items as is attributable, on a pro rate basis, to the amount of time such employees are engaged on the Change in the Work. No percentage shall be added to this sum.

32.2.8 No other allowance shall be made for general supervision or for foreman, or for overhead or the use of tools.

GC33. CHANGES IN SOIL CONDITIONS

33.1 If the Contractor incurs or sustains any extra expense or any loss or damage that is directly attributable to a substantial difference between the information relating to soil conditions at the work site that is contained in the Plans and Specifications or other documents made available to the Contractor for his use in preparing his tender and the actual soil conditions encountered by the Contractor at the work site during the performance of the Contract which could not reasonably be anticipated by the Contractor prior to tendering, he shall within 7 days of the date that the event occurred, give the Purchaser written notice of the event and of his intention to claim for that extra expense or that loss or damage.

GC34. MECHANICS' LIENS

34.1 The parties shall comply with all laws in force in the Province of Nova Scotia relating to payment periods, mandatory holdbacks, and creation and enforcement of mechanics' liens.

GC35. CONSTRUCTION SCHEDULE

35.1 Not later than one week after the award of the Contract, the Contractor shall furnish to the Purchaser for approval a Construction Schedule which shall conform to the Preliminary Construction Schedule submitted at the time of tender and which shall be based on projected information provided by the Purchaser but shall show in such greater detail as may be required by the Purchaser, the proposed starting and completion date for the various divisions and subdivisions and types and classes of work. If the Purchaser so requires, such Construction Schedule shall be prepared in such a manner as to facilitate "Critical Path Method" planning. After approval by the Purchaser the Contractor shall furnish to the Purchaser a copy of the approved Construction Schedule.

35.2 The Contractor shall complete each portion of the Work on or before the date set forth in the approved Construction Schedule. Such schedule should show earliest and latest possible starting and completion dates (Float).

35.3 If required by the Purchaser, the Contractor shall submit in writing a general description of the manner in which the Work is to be carried out and a detailed description of the manner in which each portion of the Work is to be carried out together with a list of the construction plant and equipment which he proposes to use. The description shall be submitted within 7 days of receipt of a written request from the Purchaser.

GC36. CLAIMS BY THIRD PARTIES

36.1 The Contractor shall discharge all its lawful obligations and shall satisfy all lawful claims against it arising out of the performance of the Work at least as often as the Contract requires the Purchaser to pay the Contractor.

36.2 The Contractor shall, whenever requested to do so by the Purchaser, make a statutory declaration deposing to the existence and condition of any obligations and claims referred to in GC36.1.

36.3 The Purchaser may, in order to discharge lawful obligations of and satisfy lawful claims against the Contractor arising out of the performance of the Contract, pay any amount that is due and payable to the Contractor pursuant to the Contract directly to the obligees of and the claimants against the Contractor.

36.4 A payment pursuant to GC36.3 is, to the extent of the payment, a discharge of the Purchaser's liability to the Contractor under the Contract and may be deducted from an amount payable to the Contractor under the Contract.

36.5 GC36.6 shall only apply to claims and obligations that have been received by the Purchaser in writing before payment to the Contractor pursuant to the Contract, and within 120 days after a claimant

36.5.1 should have been paid in full under its contract with the Contractor where the claim is for money that was lawfully required to be held back from the claimant; or

36.5.2 performed the last of the service, work or labour, or furnished the last of the material pursuant to its contract with the Contractor, where the claim is not for money referred to in GC36.5.1.

GC37. PAYMENT

37.1 Before submitting the first Progress Estimate pursuant to GC37.2, the Contractor shall submit to the Purchaser for approval a Schedule of Values of the various divisions of the Work as required by the Purchaser. The total sum of the values must not exceed the Contract Price. The approved Schedule of Values shall be used by the Purchaser as the basis for approval of the Progress Estimate.

37.2 Within 10 working days following the month in which the Work has been performed by the Contractor the Contractor shall submit to the Purchaser for verification, a fully itemized statement in a form specified by the Purchaser, herein referred to as the Progress Estimate showing the estimated value of the Work completed up to that date, together with a fully itemized statement of the values of the major items of materials on the site which are intended for incorporation into the Work. Invoices shall be submitted to substantiate values of the major items of materials.

37.3 Ten percent (10%) of all monies earned by the Contractor in accordance with the Progress Estimates and the final measure up to a limit of ten percent (10%) of the Contract Price, shall be retained by the Purchaser and shall be termed the Holdback.

37.4 Each Progress Estimate will show the Purchaser's gross evaluation of the Work and the deduction of the appropriate amount of the Holdback and of the previous payments to the Contractor.

37.5 No Progress Estimate shall be issued if its net value would have been less than $1,000 and the Purchaser may withhold any Progress Estimate if the Work is not being carried out in accordance with the Contract.

37.6 No Progress Estimate shall be held to bind the Purchaser in his valuation of the Work for any subsequent Estimate, and may, make correction or modification to any previous Progress Estimate which he may have issued.

37.7 The amount due to the Contractor for each Progress Estimate shall be paid by the Purchaser to the Contractor within twenty-one (21) days of the release of same by the Purchaser.

37.8 Within forty-five (45) days after the issue by the Purchaser of a Certificate of Completion of the Work, provided that the Contractor has provided the Purchaser with documents required in GC28 and/or GC29, the Owner shall release to the Contractor the amount indicated on the Certificate.

In the event of termination of the Contract under GC45, the Contractor shall be entitled to reimbursement of Costs as set out in GC37.2 which were incurred up to the effective date of termination, including the Contractor's cost of demobilizing all contractor's supervisory and administrative staff and equipment on the work site and subject to the approval of the Purchaser.

GC38. CUSTOMS DUTIES

38.1 All duties on imported items shall be deemed to have been included in the Contract Price. The Contractor shall pay all duties levied. If the Contractor considers that any duty charged to him is inappropriate, he may apply, on his own behalf, for remission of such duty.

38.2 The Contractor shall supply to the Purchaser a list of items on which duty has been paid, indicating those items on which applications for remission have been filed. If duty has been paid on an item (without application for remission) which, in the Purchaser's opinion, should be duty free, the Purchaser may direct the Contractor to apply for remission of duty.

Any amount of duty so recovered shall be for benefit of the Purchaser, after deduction of incurred expenses.

38.3 The Purchaser reserves the right to pay any duty in dispute between the Contractor and/or any Sub-Contractor vis-a-vis Canada Customs if such dispute, in the opinion of the Purchaser, threatens to jeopardize the completion of any part of the Work as required by the approved schedules, by delaying equipment in bond. Any such payments by the Purchaser will be deducted from payments otherwise due to the Contractor; provided, however, the Purchaser first notifies the Contractor, in writing, demanding the Contractor settle said dispute and secure release of such equipment within 15 days of such notice and demand; and the Contractor thereafter fails to secure such release of equipment.

GC39. RECORDS TO BE KEPT BY CONTRACTOR

39.1 When payment is to be on a cost reimbursable basis pursuant to GC32.2, the Contractor shall

39.1.1 maintain full records of any estimated and all actual costs related to its performance of the Contract, together with all correspondence, invoices, receipts and vouchers relating thereto;

39.1.2 maintain an independent record of all Federal and Provincial tax paid;

39.1.3 make all records an material referred to in GC40.1.1 available to audit and inspection by the Purchaser or by persons acting on his behalf when requested;

39.1.4 allow any of the persons referred to in 40.1.3 to make copies of and to take extracts from any of the records and materials referred to in GC40.1.1; and

39.1.5 furnish any information referred to in GC30.1.2 along with any additional information that may be required from time to time in connection with such records and materials.

39.1.6 The records maintained by the contractor pursuant to 40.1.1 shall be kept intact by the Contractor until the expiration of two years after the date that a Certificate of

Completion referred to in GC29 was issued or until the expiration of such other period of time as the Purchaser may direct in writing.

39.1.7 The contractor shall cause all other persons directly or indirectly controlled by or affiliated with the Contractor and all persons directly or indirectly having control of the Contractor to comply with GC40 as if they were the Contractor.

GC40. AUDIT BY THE PURCHASER

40.1 The Purchaser or any of its duly authorized representatives shall have the right to perform periodic audits of all books of accounts, documents, financial statements, purchase orders, payrolls and other records of the Contractor including intra-and inter-company memoranda, correspondence or instructions, as well as correspondence with vendors, carriers, public authorities and others, and accounting procedures and practices relating to the Work at such reasonable times and places as may be determined by the Purchaser.

GC41. FINAL PLAN

41.1 As the work progresses, the Contractor shall record on one (1) set of the Construction Plans all changes and deviations from the Construction Plans and Drawings, in locations, elevations and grades of pile centers, foundations, walls, footings, pedestals, piers and other salient features, including conduit, cable runs, sewers, drainage lines, manholes and all other service and drainage system with their appurtenances, both inside and outside the building, which are to be buried or otherwise concealed from view. The Contractor shall accurately record the final locations, elevations and sizes of the aforementioned by off-set distances, to permanent, visible reference features such as foundation of buildings or column lines.

41.2 At the completion of the Work, or such parts of the Work, the Contractor shall deliver the marked-up records and prints to the Purchaser.

GC42. TAKING THE WORK OUT OF THE CONTRACTOR'S HANDS

42.1 The Purchaser may, at his sole discretion, take all or any part of the Work out of the Contractor's hands, and may employ such means as he sees fit to have the Work completed

42.1.1 if the contractor has not, within six working days after receiving notice given by the Purchaser in accordance herewith remedied any delay in the commencement or any default in the diligent performance of the Work to the satisfaction of the Purchaser;

42.1.2 has defaulted in the completion of any part of the Work within the time fixed for its completion by the Contract;

42.1.3 has become insolvent;

42.1.4 has committed an act of bankruptcy;

42.1.5 has abandoned the Work;

42.1.6 has made an assignment of the Contract without the consent required hereby; or

42.1.7 has otherwise failed to observe or perform any of the provisions of the Contract

42.2 If the whole or any part of the Work is taken out of the Contractor's hands pursuant to GC43.1

42.2.1 the Contractor's right to any further payment that is due or accruing due under the Contract is, subject only to GC43.4, extinguished, and

42.2.2 the Contractor is liable to pay the Purchaser, upon demand, an amount that is equal to the amount of all loss and damage incurred or sustained by the Purchaser in respect of the Contractor's failure to complete the Work.

42.3 If the whole or any part of the Work that is taken out of the Contractor's hands pursuant to GC42.1 is completed by the Purchaser, the Purchaser shall determine the amount, if any, of a holdback or a progress claim that had accrued and was due prior to the date on which the Work was taken out of the Contractor's hands and that is not required for the purposes of having the Work performed or of compensating the Purchaser for any other loss or damage incurred or sustained by reason of the Contractor's default.

42.4 The Purchaser may pay the Contractor the amount determined not to be required pursuant to GC42.3.

42.5 The taking of the Work or any part thereof out of the Contractor's hands pursuant to this paragraph shall not operate so as to relieve or discharge it from any obligation under the contract or imposed upon it by law except the obligation to complete the performance of that part of the Work that was taken out of its hands.

42.6 The Contractor, on receiving notice pursuant to GC42.1 shall promptly vacate those areas in which it is no longer required to perform the Work, and shall fully cooperate with and coordinate the balance of the Work with the Purchaser or Other Contractors employed to make good the Work.

GC43. SUSPENSION OF WORK BY PURCHASER

43.1 The Purchaser may, when in his opinion it is in the Purchaser's interest to do so, require the Contractor to suspend performance of the Work either for a specified or an unspecified period by giving notice of suspension to the Contractor in accordance with GC13.

43.2 When a notice referred to in GC43.1 is received by the Contractor, the Contractor shall suspend all operations in respect of the Work that, in the opinion of the Purchaser, are necessary for the care and preservation of the Work, plant and material.

43.3 The Contractor shall not, during a period of suspension, remove any part of the Work, plant or material from its site without the consent of the Purchaser.

43.4 If a period of suspension is 90 days or less, the Contractor shall, upon expiration of that period, resume its performance of the Work.

43.5 If, upon the expiration of a period of suspension of more than 90 days, the Purchaser and the Contractor agree that the performance of the Work shall be continued by the Contractor, the Contractor shall resume its performance of the Work subject to terms and conditions agreed upon by the Purchaser and the Contractor.

43.6 If, upon the expiration of a period of suspension of more than 90 days, the Purchaser and the Contractor do not agree that performance of the Work will be continued by the Contractor, the notice of suspension shall be deemed notice of termination pursuant to GC44.

43.7 Neither party to this Agreement shall be liable to the other and neither party shall be legally in default hereunder for any failure or delay in performing any covenant or agreement hereunder, if such failure or delay arises from a cause not reasonably within the control of such party, including, without limitation, acts of God, strikes, lockouts or other industrial disputes, acts of a public enemy, war, riots, fire, storm, flood, explosion, government approvals, unavailability of equipment or machinery or other like causes. The party which invokes force majeure shall give prompt notice thereof to the other of the commencement and termination of the cause or causes referred to above.

43.8 If an event as referred to GC43.7 arises, the time for performance of any covenant agreement under this Agreement affected thereby shall be extended for the period of delay, provided that the party invoking force majeure shall take all reasonable steps and use all due diligence to remove or remedy the cause of the delay.

43.9 If an occurrence of force majeure extends for a period of delay of more than three (3) months, either party may terminate this Agreement by notice to the other party, and in such event the Purchaser shall advance to the Contractor any payments which may be payable hereunder in consideration of the Contractor's proper and efficient performance of the Work up to the date of commencement of the delay.

GC44. TERMINATION

44.1 The Purchaser may terminate the contract at any time by giving a notice of termination to the Contractor in accordance with GC13.

44.2 When a notice referred to in 44.1 is received by the Contractor, it shall, subject to any conditions stipulated in the notice, forthwith cease all operations in performance of the Contract.

44.3 If the Contract is terminated pursuant to GC44.1 the Purchaser shall pay the Contractor an amount calculated in accordance with paragraph GC37.8.

GC45. NO PARTNERSHIP, ETC.

45.1 The liability of the parties hereto shall be several and not joint or collective; and each party shall be responsible only for its obligations as herein set forth; and neither this Agreement nor anything herein creates any of the relationships of partnership, agent, joint venture or employer and employee between the Purchaser and the Contractor, or between the Purchaser and any of the Contractor's agents, partners, sub-contractors or employees.

GC46. CONNECTING WORK

46.1 The Contractor shall do all cutting, fitting or patching that may be required to make the parts of the Work come together properly or to connect to the Work of others as shown upon or reasonably implied by the Contract Documents and as the Purchaser may direct.

46.2 The Contractor shall not endanger any existing work by cutting, digging, or otherwise, and shall not cut or alter the Work of any other Contractor save with the consent of the Purchaser. Should the contractor cause damage to other work, then the Contractor shall reimburse the Purchaser for the Corrective work necessary or immediately arrange, and at his own expense, repairs made to correct said damage.

GC47. TEMPORARY STRUCTURES

47.1 The Contractor shall take precautions to ensure that shoring, construction equipment, materials, or any of its operations or those of its Sub-Contractors, or forces of nature, which apply loads to any part of the Work shall not damage the Work.

47.2 All shoring, falsework and similar temporary structures shall be designed by an engineer authorized to practice in Nova Scotia and all drawings, specifications and instructions related thereto must bear his/her seal and signature and copies shall be furnished to the Purchaser.

Drawings, specifications and instructions relating to temporary structures described in the Contract Documents must be examined by the Purchaser before construction of such temporary structures is commenced and comply with applicable Federal or Provincial regulations.

GC48. MEASUREMENT OF THE WORK

48.1 Approximate measurements of the Work completed under a Unit Price Contract shall be made by the Purchaser during the progress of the Work. An authorized representative of the Contractor shall assist the Purchaser in taking such measurements and shall furnish all particulars required by the Purchaser.

48.2 The said measurements shall not bind the Purchaser in any manner in the preparation of his final measurement of the Work constructed by the Contractor under this Contract, but shall be construed and held to be approximate only.

48.3 The final measurement shall be carried out as soon as the whole of the Work has been completed and this final measurement must be approved and accepted by both the Purchaser and the Contractor.

Labour Canada   Travail Canada

LABOUR CONDITIONS
CONDITIONS DE TRAVAIL

General Conditions - Appendix I

Interpretation

1. In these conditions

(a) "Act" means the *Fair Wages and Hours of Labour Act;*

(b) "Regulations" means the Fair Wages and Hours of Labour Regulations made pursuant to the Act;

(c) "contract" means the contract to which these Labour Conditions are attached;

(d) "contracting authority" means the department of Government or Corporation that is an agent of Her Majesty with whom the contract is made;

(e) "contractor" means the person who has entered into the contract with the contracting authority;

(f) "Director" means a regional director of the Department of Labour located at Moncton, Montreal, Toronto, Winnipeg and Vancouver."

(g) "fair wage officer" means the officer of the Canada Department of Labour designated by the Minister of Labour;

(h) "Minister" means the Canada Minister of Labour;

(i) "persons" means those workers employed by the contractor, subcontractor or any other person doing or contracting to do the whole or any part of the work contemplated by the contract.

(j) "road, sewer and watermain construction" means clearing and preparing a right of way, excavation and subgrading, laying a granular base, grading and asphalt and concrete paving and includes

- (a) the operation of on-site plants to service such construction,
- (b) the installation of drainage,
- (c) landscaping,
- (d) the demolition of structures within or affected by a right of way, and
- (e) all other work involved in
  - (i) the construction, reconstruction and maintenance of roads, highways, streets, sidewalks, curbs, parking lots, driveways, airport runways, airport taxi strips and aircraft parking aprons, and
  - (ii) the installation, reinstallation and maintenance of sewers and watermains.

Wage Rates

2.

(a) All persons, in the employ of the contractor, sub-contractor, or any other person doing or contracting to do the whole or any part of the work contemplated by the contract shall during the continuance of the work be paid fair wages: that is, such wages as are generally accepted as current for competent workers in the district in which the work is being performed for the character or class of work in which such

Interprétation

1. Dans ces conditions

a) "Loi" désigne la *Loi sur les justes salaires et les heures de travail;*

b) "Règlement" désigne le Règlement sur les justes salaires et les heures de travail établi en application de la Loi;

c) "contrat" désigne le contrat auquel sont annexées les présentes conditions de travail;

d) "adjudicateur" désigne le ministère du gouvernement ou la société qui est un agent de Sa Majesté avec lequel le contrat a été passé;

e) "entrepreneur" désigne la personne qui a passé le contrat avec l'adjudicateur;

f) "directeur" désigne un directeur régional du ministère du Travail en poste à Moncton, Montréal, Toronto, Winnipeg et Vancouver."

g) "agent des justes salaires" désigne l'agent du ministère du Travail du Canada désigné par le ministre du Travail;

h) "Ministre" désigne le ministre du Travail du Canada;

i) "personnes" désigne les travailleurs employés par l'entrepreneur, le sous-traitant ou toute autre personne exécutant on s'engageant par contrat à exécuter la totalité ou une partie quelconque des travaux prévus dans le contrat.

j) "construction des routes, égouts et canalisations d'eau" désigne le défrichement et la préparation de l'emprise, les travaux de déblai, l'exécution de la sous-couche et de la couche de base en granulats, le nivellement, le revêtement de surface en liants bitumineux ou en béton de ciment, y compris

- a) les installations de chantier nécessaires aux travaux susmentionnés,
- b) le drainage,
- c) l'aménagement paysager,
- d) la démolition des structures empiétant sur l'emprise ou affectées par celle-ci et
- e) tous les travaux connexes intéressant
  - (i) la construction, la réfection ou l'entretien des routes, autoroutes, rues, trottoirs, bordures, terrains de stationnement et allées pour automobiles, des pistes d'envol, pistes de circulation et aires de stationnement des aéroports, et
  - (ii) la construction, la réinstallation et l'entretien des égouts et des canalisations d'eau.

Taux de salaire

2.

a) A toutes les personnes employées par l'entrepreneur, le sous-traitant ou toute autre personne exécutant ou s'engageant par contrat à exécuter la totalité ou une partie quelconque des travaux prévus dans le contrat, il sera payé, tant que dureront les travaux, des justes salaires, c'est-à-dire les salaires généralement reconnus comme salaires courants pour les travailleurs qualifiés dans la région ou les travaux sont exécutés, selon la nature ou la catégorie du travail auquel ces travailleurs sont respectivement

workers are respectively [illegible] for each classification of w[illegible] set out in Appendix A to these [illegible] and in no case shall the wage rates [illegible] minimum hourly rate of pay prescribed [illegible] Part III of the Canada Labour Code (Labour Standards).

(b) The Director may determine at any time and from time to time what are the current or fair and reasonable rates of wages for the purpose of the contract, and may revise the wage rates in Appendix A attached to these Labour Conditions during the term of the contract.

The contractor agrees that where during the term of the contract he receives from the contracting authority a copy of any change in the wage rates referred to in the above paragraph, the contractor will pay not less than the wage rates as changed commencing with the first day following the receipt by him of the copy of the changed wage rates.

(c) The contractor agrees that where during the term of the contract any question arises as to the proper classification of employment of work for the purpose of the payment of fair wages, the classification shall be determined by the Director.

Hours of Work

3. (a) Except as provided in paragraph (d) and Section 13, the working hours of persons employed in the execution of the contract shall not exceed 8 hours in a day or 48 hours in a week except where longer daily or weekly hours are authorized by the Minister in cases of exceptional circumstances.

(b) Except as provided in Section 13, all persons shall be paid for hours worked in excess of 8 hours in a day or 40 hours in a week at an overtime rate at least one and one-half times the wage rates required to be paid under these Labour Conditions, as set out in Section 2(a).

(c) Except as provided in Section 13, all applications for permission to exceed 8 hours in a day or 48 hours in a week shall be made to the contracting authority for reference to the Minister.

(d) The daily or weekly hours of work set out in paragraph (a) or Section 13, or authorized by the Minister under paragraph (a) or Section 13, may be exceeded where there is serious interference with the ordinary carrying out of the work contemplated by the contract by reason of:

(i) an accident involving injury to a worker,

(ii) a breakdown of or damage to machinery or equipment, or

(iii) other unforeseen, unpreventable or emergent circumstances,

but only to the extent necessary to prevent such serious interference.

(e) Where because of serious interference referred to in paragraph (d) the working hours of any worker exceeded the weekly hours of work set out in paragraph (a) or Section 13, or authorized by the Minister under paragraph (a) or Section 13, the contractor shall report in writing to the Director, within fifteen days after the end of the week in which such hours of work were exceeded, setting forth:

(i) the nature of the serious interference,

(ii) the names of all workers who worked in excess of weekly hours of work set out in paragraph (a) or Section 13 or authorized by the Minister under paragraph (a) or Section 13, and

(iii) the number of hours each worker worked in excess of the weekly hours of work referred to in sub-paragraph (ii).

affectés; les taux de salaire prévus pour chaque catégorie de travail ne devront pas être inférieurs aux taux indiqués dans l'Annexe A aux présentes conditions de travail et, dans aucun cas, les taux de salaire accordés ne devront être inférieurs au taux horaire minimum prescrit par la Partie III du Code canadien du travail (Normes du travail).

b) Le Directeur pourra en tout temps et à l'occasion déterminer quels sont les taux de salaire courants ou justes et raisonnables, pour les fins du contrat, et pourra revoir les taux de salaire indiqués dans l'Annexe A jointe aux présentes conditions de travail pendant la durée du contrat.

L'entrepreneur convient que s'il reçoit de l'adjudicateur, pendant la durée du contrat, un exemplaire de toute modification aux taux de salaire mentionnés dans l'alinéa ci-dessus, il ne paiera pas moins que les taux de salaire modifiés, à compter du premier jour qui suit la réception par lui, d'un exemplaire des taux de salaire modifiés.

c) L'entrepreneur convient que s'il surgit quelque doute, pendant la durée du contrat, quant à la catégorie appropriée d'emploi ou de travail aux fins du paiement des justes salaires, il appartiendra au Directeur de déterminer la catégorie.

Durée du travail

3. a) Sauf dispositions contraires à l'alinéa d) et à l'article 13, la durée du travail des personnes employées à l'exécution du contrat ne devra pas dépasser 8 heures par jour ni 48 heures par semaine, sauf lorsqu'une journée ou une semaine de travail plus longue a été autorisée par le Ministre en raison de circonstances exceptionnelles.

b) Sauf dispositions contraires à l'article 13, toutes les personnes seront rémunérées, pour les heures de travail effectuées en sus de 8 par jour ou de 40 par semaine, à des taux majorés au moins égaux à une fois et demie les taux de salaire exigés, dans les présentes conditions de travail, tel que défini à l'article 2a).

c) Sauf dispositions contraires à l'article 13, toutes les demandes d'autorisation de travail au-delà de 8 heures par jour ou de 48 heures par semaine devront être adressées à l'adjudicateur pour être transmises au Ministre.

d) La durée journalière ou hebdomadaire du travail énoncée dans l'alinéa a) ou l'article 13, ou autorisée par le Ministre, en vertu de l'alinéa a) ou de l'article 13, peut être dépassée en cas de danger d'entrave grave à la marche ordinaire des travaux prévus aux termes du contrat par suite:

(i) d'un accident ayant causé une lésion à un employé,
(ii) d'une panne ou de l'endommagement de l'outillage ou des appareils, ou
(iii) d'autres circonstances imprévues, inévitables ou fortuites,

mais uniquement dans la mesure nécessaire pour prévenir une telle entrave grave à la marche des travaux.

e) Lorsque, par suite du danger d'entrave grave à la marche des travaux mentionné dans l'alinéa d), la durée du travail d'un employé a dépassé la durée hebdomadaire du travail énoncée dans l'alinéa a) ou dans l'article 13, ou autorisée par le Ministre, en vertu de l'alinéa a) ou de l'article 13, l'entrepreneur doit adresser par écrit au Directeur, dans les quinzes jours qui suivent la fin de la semaine au cours de laquelle la durée du travail a été dépassée, un rapport indiquant:

(i) la nature de l'entrave grave à la marche des travaux,

(ii) les noms de tous les employés qui ont fourni des heures supplémentaires en excédent de la durée hebdomadaire du travail énoncée dans l'alinéa a) ou dans l'article 13, ou autorisée par le Ministre en vertu de l'alinéa a) ou de l'article 13, et

(iii) le nombre d'heures supplémentaires fournies par chacun d'entre eux en excédent de la durée hebdomadaire du travail mentionnée dans le sous-alinéa (ii).

ur Conditions to be Posted

the protection of all persons the contractor agrees to post and keep posted, in a conspicuous place on the premises where work contemplated by the contract is being carried out or on premises occupied or used by persons engaged in carrying out such work, a copy of these Labour Conditions, and any authorization by the Minister to exceed the maximum hours specified in Section 3(a) or 13(a).

The Contractor to keep Records which are to be Kept open for Inspection

5. The contractor agrees to keep proper books and records showing the names, addresses and classifications of employment and work of all workers employed in work under the contract and the rate of wages, the wages paid and the daily hours worked by such workers.

The contractor also agrees to undertake that his books, records and premises will be open at all reasonable times for inspection by the Minister, a fair wage officer or any other person designated by the Minister.

The contractor also agrees to furnish the Minister, the contracting authority, the fair wage officer or other person designated by the Minister, on request, with such further information as is required to ascertain that the requirements of the Act, the Regulations and the contract with respect to wages, hours of work and other labour conditions have been complied with.

Departmental Requirements before Payments made to Contractor

6. The contractor agrees that he will not be entitled to payment of any money otherwise payable under the contract until he has filed with the contracting authority in support of his claim for payment a sworn statement;

(i) that he has kept the books and records required by these Regulations;
(ii) as to whether any wages in respect of work performed under the contract remain in arrears, and
(iii) that to his knowledge, all the conditions in the contract required by the Act and the Regulations have been complied with.

The contractor also agrees that, where the Minister informs the contracting authority and the contractor that fair wages and overtime rates have not been paid by the contractor to persons employed under the contract, the contracting authority will be entitled to withhold from any monies otherwise payable under the contract the amount the Minister indicates should be withheld until such time as the matter has been dealt with to the satisfaction of the Minister.

Authority to Pay Wages in the Event of Default by the Contractor

7. The contractor agrees that where he is in default of payment of wages to an employee the contractor will send to the Minister a cheque payable to the Receiver General for Canada for the amount determined by the Minister as being the amount the contractor is in default.

The contractor agrees that when he fails to comply with the preceding provision, the Minister may instruct the contracting authority to pay to the Receiver General for Canada, out of any monies otherwise payable to the contractor, the amount determined by the Minister as being the amount the contractor is in default.

Conditions of Subcontracting

8. The contractor agrees that in subcontracting any part of the work contemplated by the contract, he will place in the subcontract conditions respecting wages, hours of work and other labour conditions set out in the contract; and also the contractor agrees that he will be responsible for the carrying out of these conditions.

Affichage des conditions de travail

4. Pour la protection de toutes les personnes, l'entrepreneur s'engage à afficher et à tenir affichés, bien à la vue, à l'endroit où les travaux prévus dans le contrat sont exécutés, ou dans les locaux occupés ou fréquentés par les personnes employées à l'exécution desdits travaux, un exemplaire des présentes conditions de travail, de même qu'un exemplaire de toute autorisation de prolongation de la durée du travail au-delà du seuil prescrit aux articles 3a) ou 13a) accordée par le Ministre.

L'entrepreneur s'engage à tenir des dossiers pour fins d'inspection

5. L'entrepreneur s'engage à tenir les registres et dossiers appropriés indiquant le nom, l'adresse et la catégorie d'emploi et de travail de tous les travailleurs employés à des travaux exécutés en vertu du contrat, de même que le taux de salaire, le salaire payé et la durée journalière du travail pour chacun de ces travailleurs.

L'entrepreneur s'engage également à faire en sorte que ses registres, ses dossiers et ses locaux soient accessibles en tout temps opportun, pour fins d'inspection par le Ministre, un agent des justes salaires ou toute autre personne désignée par le Ministre.

L'entrepreneur s'engage en outre à fournir, sur demande, au Ministre, à l'adjudicateur, à l'agent des justes salaires ou à toute autre personne désignée par le Ministre tous autres renseignements requis pour permettre de constater qu'on a satisfait aux exigences de la Loi, des règlements et du contrat en ce qui concerne les salaires, la durée du travail et les autres conditions de travail.

Exigences du ministère avant le versement des sommes dues à l'entrepreneur.

6. L'entrepreneur convient qu'il n'aura droit au paiement d'aucune somme qui autrement devrait lui être versée en vertu du contrat tant qu'il n'aura pas déposé auprès de l'adjudicateur, à l'appui de sa réclamation de paiement, une déclaration sous serment indiquant:

(i) qu'il a tenu les registres et dossiers requis par les présents règlements,
(ii) si des salaires à l'égard des travaux exécutés en vertu du contrat demeurent impayés et
(iii) qu'à sa connaissance, toutes les conditions du contrat exigées par la Loi et les règlements ont été observées.

L'entrepreneur convient en outre que si le Ministre fait savoir à l'adjudicateur et à l'entrepreneur que des justes salaires et des taux applicables aux heures supplémentaires n'ont pas été payés par l'entrepreneur à des personnes employées en vertu du contrat, l'adjudicateur sera autorisé à retenir de toute somme autrement payable en vertu du contrat le montant indiqué par le Ministre comme devant être retenu jusqu'à ce que la question ait été réglée à la satisfaction du Ministre.

Paiement des salaires par l'adjudicateur, si l'entrepreneur omet de le faire

7. L'entrepreneur convient qu'à défaut de paiement de salaire à un travailleur, de sa part, il devra envoyer au Ministre un chèque établi à l'ordre du Receveur général du Canada, au montant déterminé par le Ministre comme étant le montant que l'entrepreneur a omis de payer.

L'entrepreneur convient que s'il omet de se conformer à la disposition ci-dessus, le Ministre peut ordonner à l'adjudicateur de payer au Receveur général du Canada, à même les sommes autrement payables à l'entrepreneur, le montant déterminé par le Ministre comme étant le montant que l'entrepreneur a omis de payer.

Conditions imposées à un sous-traitant

8. L'entrepreneur convient que dans l'adjudication, à un sous-traitant, de toute partie des travaux prévus par le contrat, il devra insérer dans le sous-contrat les conditions concernant les salaires et la durée du travail et les autres conditions de travail indiquées dans le contrat; l'entrepreneur reconnaît en outre qu'il sera responsable de l'observation desdites conditions.

Workers to be Residents of Canada

9. The contractor agrees [illegible] employed by him to do any work under the [illegible] Canada unless in the opinion of the [illegible] the time the work is to commence under the [illegible]

(a) persons resident in Canada are not available to do the work, or

(b) special circumstances exist whereby it would not be in the public interest to require that all such persons be residents of Canada.

Non-discrimination in Hiring and Employment of Labour

10. The contractor agrees that

(a) in the hiring and employment of workers to perform any work under the contract, the contractor will not refuse to employ and will not discriminate in any manner against any person because

(i) of that person's race, national origin, colour, religion, age, sex or marital status,

(ii) of the race, national origin, colour, religion, age, sex, or marital status of any person having any relationship or association with that person, or

(iii) a complaint has been made or information has been given by or in respect of that person relating to an alleged failure by the contractor to comply with subparagraph (i) or (ii);

(b) if any question arises as to whether the contractor has failed to comply with the provision described in paragraph (a), the Minister or any person designated by the Minister shall decide the question and his decision shall be final for the purposes of the contract; and

(c) failure to comply with the aforementioned clauses (a) and (b) regarding non-discrimination shall constitute a material breach of the contract.

Liquidated Damages

11. In the event of any default in carrying out any of the conditions set out in Sections 2, 3 and 13 of these Labour Conditions in respect of any employee, the contractor shall pay to Her Majesty as liquidated damages a sum of fifty dollars for every such default, and the Minister under whom the work contemplated by the contract is being executed may direct that the amount assessed as liquidated damages under this paragraph be deducted from any moneys payable to the contractor under the contract and be credited to the Consolidated Revenue Fund.

Schedule of Wage Rates

12. A schedule of minimum wage rates, authorized by the Canada Department of Labour, when attached to these Labour Conditions as Appendix A also becomes part of the contract.

Contracts exclusively for Road, Sewer and Watermain Construction.

13. In a contract which is EXCLUSIVELY for road, sewer and watermain construction:

(a) the working hours of persons shall not exceed 60 hours in a week except where longer weekly hours are authorized by the Minister under the Act.

(b) All persons shall be paid for hours worked in excess of 10 hours in a day or 50 hours in a week at an overtime rate at least one and one-half times the wage rates required to be paid under these Labour Conditions, as set out in Section 2(a)

(c) An application for authorization by the Minister to exceed the working hours specified in paragraph (a) shall be forwarded to him through the contracting authority.

Les travailleurs doivent résider au Canada

9. L'entrepreneur convient que toutes les personnes employées par lui pour exécuter un travail quelconque en vertu du contrat doivent résider au Canada, à moins que, de l'avis de l'adjudicateur, à la date prévue pour le début des travaux en vertu du contrat,

a) il ne se trouve pas de personnes résidant au Canada disponibles pour exécuter les travaux, ou

b) il existe des circonstances spéciales par suite desquelles il ne serait pas dans l'intérêt public d'exiger que toutes les personnes en question résident au Canada.

Non-discrimination dans l'embauchage et l'emploi de main-d'oeuvre

10. L'entrepreneur convient que

a) dans l'embauchage et l'emploi des travailleurs aux fins de l'exécution de tout travail en vertu du contrat, l'entrepreneur ne refusera pas d'employer une personne ou d'exercer de quelque façon que ce soit des distinctions injustes à l'endroit d'une personne à cause

(i) de la race, de l'origine nationale, de la couleur, de la religion, de l'âge, du sexe ou de l'état civil de cette personne,

(ii) de la race, de l'origine nationale, de la couleur, de la religion, de l'âge, du sexe ou de l'état civil de toute personne ayant un rapport ou une association avec la personne en question, ou parce que

(iii) cette dernière a porté plainte ou a fourni des renseignements ou parce qu'une plainte a été portée ou des renseignements ont été fournis en son nom relative-à toute prétendue omission de la part de l'entrepreneur de se conformer aux sous-alinéas (i) ou (ii);

b) en cas de doute sur la question de savoir si l'entrepreneur a négligé de se conformer aux dispositions de l'alinéa a), le Ministre ou toute autre personne désignée par le Ministre tranchera la question et sa décision sera sans appel aux [illegible] du contrat;

c) toute omission de se conformer aux conditions a) et b) ci-dessus concernant la non-discrimination constituera un manquement grave au contrat.

Dommages-intérêts déterminés à l'avance

11. Advenant un manquement dans l'exécution de l'une ou l'autre des conditions énoncées dans les articles 2, 3 et 13 des présentes conditions de travail en ce qui concerne un employé quelconque, l'entrepreneur doit payer à Sa Majesté, au titre de dommages-intérêts fixés à l'avance, cinquante dollars pour chaque manquement, et le Ministre sous la juridiction de qui le travail prévu par le contrat est en voie d'exécution peut ordonner que le montant auquel ont été fixés les dommages-intérêts prédéterminés ainsi que le prévoit le présent alinéa soit déduit de toute somme payable à l'entrepreneur aux termes du contrat et soit crédité au Fonds du revenu consolidé.

Échelle de salaires

12. Une échelle de salaires minimums reconnue par le ministère du Travail du Canada, jointe aux présentes conditions de travail en tant qu'Annexe A, devient également partie intégrante du contrat.

Contrats adjugés exclusivement pour la construction de routes, d'égouts et de canalisations d'eau.

13. Dans un contrat adjugé EXCLUSIVEMENT pour la construction de routes, d'égouts et de canalisations d'eau:

a) la durée du travail des personnes ne doit pas dépasser 60 heures par semaine, sauf lorsqu'une semaine de travail plus longue a été autorisée par le Ministre en vertu de la Loi.

b) Toutes les personnes seront rémunérées, pour les heures de travail effectuées en sus de 10 par jour ou de 50 [illegible] semaine, à des taux majorés au moins égaux à une foi[illegible] demie les taux de salaire exigés dans les présentes con[illegible]tions de travail, tel que défini à l'article 2a).

c) Une demande d'autorisation, par le Ministre, de travail au-delà des heures prescrites à l'alinéa a) devra être adressé[illegible] au Ministre par l'entremise de l'adjudicateur.

Section 5 - General Requirements

5.1 Contract Number
5.2 Location of the Work
5.3 Subdivision of the Work
5.4 Project Meeting
5.5 Codes and Standards
5.6 Notification
5.7 Tests and Inspections
5.8 Equipment, Materials and Workmanship
5.9 Handling, Shipping and Storage
5.10 Design Provisions and Alternatives
5.11 Document Identification
5.12 Contractor Drawings and Specifications
5.13 Equipment Manuals
5.14 Purchaser Supplied Equipment
5.15 Start-Up
5.16 Performance Guarantee

5. GENERAL REQUIREMENTS

This section of the Tender document provides general information and guidelines for the Contractor necessary to carry out the stated work in Section 6, Description of Work. These General Requirements of the Contractor apply to all the work associated with the removal, relocation, installation and conversion of the boiler and ancillaries, and its performance when restarted following such work.

5.1 CONTRACT NUMBER

A Purchase Order number will be assigned to this Contract which will serve as the Contract Number to be referred to on all related documentation. The conditions stated on the Purchase Order are superceded by the Articles of Agreement of the Contract.

5.2 LOCATION OF THE WORK

The boiler, stack, equipment and parts to be removed are located at the Glace Bay Heavy Water Plant of the Atomic Energy of Canada Ltd., Glace Bay, N.S. They are to be relocated to the site of the Minas Basin Pulp and Power Co., Hantsport, N.S.

5.3 SUBDIVISION OF THE WORK

1. The work specified in Section 6, Description of Work, has generally been divided into sequential tasks. The division of the work among subcontractors and suppliers is solely the responsibility of the Contractor and the Purchaser assumes no responsibility to act as an arbiter to establish subcontract limits between any divisions of the work.

2. Extras will not be considered based on grounds of a difference in interpretation of specifications regarding contract limits.

3 The Contractor shall make every effort to use local subcontractors, labour and suppliers, and where the Purchaser requests, the Contractor shall specifically quote prices from a stipulated subcontractor or supplier. The Contractor retains the right to select subcontractors, in accordance with Section 4.18, Subcontracting.

5.4 PROJECT MEETINGS

1. The Contractor shall attend regular project meetings for co-ordination of the Work at a date, time and place arranged by the Purchaser.

2. The meetings will be chaired by the Purchaser who shall see that minutes are recorded and copies are distributed to all parties. The Contractor's Superintendent must attend all project meetings.

3. In so far as is practical, the project meetings shall follow a prepared agenda which shall include a review of the work schedule.

5.5 CODES AND STANDARDS

1. The Steam Boiler and Pressure Vessel Act and Regulations, Revised Statutes of Nova Scotia 1982 shall govern all parts of the Work to which it applies. The most recent edition of the referenced standards and codes shall apply.

2. Any work outside the jurisdiction of the Act, including all materials and operations, shall conform to C.S.A. Standards and all other applicable standards and codes and shall be in accordance with all laws, rules and regulations governing the site of the Work.

3. All work shall meet or exceed the requirements of all applicable standards, codes and referenced documents.

4. The Work shall also meet any requirements of Factory Mutual System for the purpose of insurance specifications.

5. The Contractor shall ensure that all testing and inspections are performed as stipulated and specified in any applicable codes and regulations.

5.6 NOTIFICATION

Upon arrival of the boiler at the M B P & P site the Contractor shall notify the Chief Inspector, Nova Scotia Department of Labour and Manpower.

5.7 TESTS AND INSPECTIONS

1. The Contractor shall perform or arrange for the performance of all necessary tests and inspections, either by law or otherwise to ensure proper and safe workmanship, installation and/or operation.

2. The contractor shall notify the Purchaser at least one (1) week prior to the date of any tests or inspections and the Purchaser reserves the right to witness any and all tests and inspections.

3. Certified test and inspection reports shall be submitted to the Purchaser regardless of any attendance by the Purchaser during tests and inspections.

4. If, upon testing or inspection, any component does not meet the specified performance requirements the Contractor shall immediately implement such modifications as necessary to achieve compliance and repeat the test procedures. The Contractor shall have no claim against the Purchaser for any financial loss he may suffer from the rejections of any materials or work due to their failure to meet the test or inspection requirements.

5. The cost of any required tests and inspections and the cost of providing assistance, samples, etc. for such tests and inspections shall be deemed to be covered by and included in the Contract Price.

5.8 EQUIPMENT, MATERIALS AND WORKMANSHIP

1. The Contractor shall provide all equipment, tools, materials, vehicles and manpower in such quantity and condition to perform the specified work of Section 6, Description of Work in accordance with safe work practices.

2. All materials supplied by the Contractor shall be in accordance with those specified by the Purchaser or any governing regulations and may be subjected to tests from time to time as directed by the Purchaser.

3. All workmanship which is the responsibility of the Contractor shall be done in accordance with safe work practices and by workers properly qualified in accordance with any applicable codes and regulations.

5.9 HANDLING, SHIPPING AND STORAGE

1. Any equipment, materials or parts handled by the Contractor shall be done so as to avoid any damage. If any equipment or materials are damaged, the repair or replacement shall be made by the Contractor in a manner approved by the Purchaser at no additional cost to the Purchaser.

2. Any equipment, materials or parts which the Contractor is required to ship shall be done so as to ensure its protection from weather and handling damage. Openings in equipment for field assembly of components shall be adequately sealed if necessary.

3. The Contractor shall adequately store all equipment, materials and parts intended for the Work until it has been incorporated into the completed project. The interior of all machinery, pipe, fittings and other accessories shall be kept free from dirt and foreign matter at all times. If it is necessary to store any items at the work site, the Purchaser will designate an area for this purpose.

5.10 DESIGN PROVISIONS AND ALTERNATIVES

1. The Contractor shall verify the compliance of the Purchaser's drawings and specifications with the technical requirements of the project and shall note and describe any deviations from these technical requirements. The technical requirements includes: 1) the stipulations of all applicable codes, standards and regulations; 2) the consideration of space constraints for proper location of all system components, which will provide for ease of installation and accessibility for repair and maintenance; and 3) any other items which result from the work described in Section 6, Description of Work.

2. Quotations are to be based on the Purchaser's drawings and specifications, notwithstanding any valid changes as per 1, above. Proposals for alternatives, additions or deletions should be submitted on separate sheets with all pertinent data and prices to permit evaluation.

3. All parts of the Work which are the responsibility of the Contractor, shall comply with the technical requirements of any applicable codes and regulations.

5.11 DOCUMENT IDENTIFICATION

All drawings, specifications, manuals and correspondence furnished to the Purchaser by the Contractor shall be identified with the date, Purchaser's name, plant name, project number, equipment number, equipment function and Purchase Order number.

5.12 CONTRACTOR DRAWINGS AND SPECIFICATIONS

1. The Contractor shall provide all drawings and specifications for the Work to the Purchaser for review before such work can proceed. This includes, but is not limited to the P & I Drawing (see Section 6.3.2, Installation - Balanced Draft System), the BDS Design and Design Performance Specifications (see Section 6.3.2, Installation - Balanced

Draft System), the Piping Layout Sketch (see Section 6.6.6, Installation - Piping), Canmet CWF Burner Model 1000 drawings and Dimensional and Design specifications of the ignitor (see Section 6.4.3, CWF Ignitor).

2. The Purchaser shall review and return all drawings and specifications with appropriate markings or comments to the Contractor in a prompt manner so as to cause no delay in the Work. Review of the documents by the Purchaser is solely to ascertain conformance with the general design concept. Responsibility for certification of the detail in all drawings and specifications rests with the Contractor and review by the Purchaser shall not imply such certification.

3. Only if so stated must the Contractor return the documents for re-review. Otherwise resolution of the comments by the Contractor signifies that the Work may proceed. The Contractor shall submit certified drawings to the Purchaser within two (2) weeks of the resolution of the comments.

4. Any adjustments made to the drawings or specifications by the Purchaser are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, the Contractor must clearly state as such in writing prior to proceeding with the Work.

5.13 EQUIPMENT MANUALS

1. The Contractor shall provide five (5) copies of all manufacturers literature pertaining to such equipment and which shall include descriptions, drawings, specifications, assembly, wiring or other diagrams, materials lists, parts lists, installation, operating and maintenance instructions, inspection certificates, name and address of the manufacturer's nearest agent and like information.

2. The Holdback payment will not be made before this material has been completely provided.

5.14 PURCHASER SUPPLIED EQUIPMENT

1. The Purchaser will supply the items listed in Section 7.1, Purchaser Supplied Equipment. The Contractor will install all such equipment according to the requirements in Section 6, Description of Work.

2. For any Purchaser supplied materials and equipment delivered to the worksite, the Contractor shall off-load or transport from storage to the work location, unpackage or complete

unpackaging and clean and inspect the materials and equipment. The Contractor shall report to the Purchaser any defects or deficiencies that may be found by a reasonable visual inspection.

3. After inspecting the Purchaser supplied materials and equipment the Contractor shall accept same by signing a receipt which shall constitute an acknowledgement that the materials and equipment are in good order except for latent defects and deficiencies not noticeable on reasonable visual inspection. After the signing of such receipt and until the Work is accepted by the Purchaser, the Contractor shall be liable and shall indemnify the Purchaser in respect of all loss of and damage to such materials and equipment, including defects and deficiencies which may have been discovered by a reasonable visual inspection, and of all costs of re-purchasing, re-delivering, dismantling, re-installing, repairing or restoring such materials and equipment.

4. The Purchaser makes no guarantee that the equipment will be available on the day scheduled for delivery and the Contractor shall allow reasonable tolerance on delivery dates.

5.15 START-UP

1. The Purchaser shall prepare Start-up and Commissioning Procedures for the complete installed boiler system. The Contractor will review, with the Purchaser, these procedures and verify the technical, operating and maintenance conditions and make recommendations where required.

2. The Contractor shall assist the Purchaser in the placing of equipment into preliminary service for checking and acceptance purposes prior to Start-up. The Purchaser will provide personnel for the actual operating of the equipment and assume responsibility while in operation.

3. For the purpose of Start-up, the Contractor is responsible for the condition of the Performance Guarantee (see Section 5.16). If, for any reason, the Purchaser requests the services of the Contractor for any work above and beyond the requirements of the Performance Guarantee, the Purchaser will make such requests at the times necessary and for the duration necessary. The Contractor's services in such instances will be paid for at the daily per diem rate set forth in Section 2, Form of Tender, Appendix 1.

5.16 PERFORMANCE GUARANTEE

1. The Contractor shall guarantee that he will repair or replace immediately any equipment or components furnished which prove defective in workmanship or material or fail to meet stated performance specifications during the warranty period, at no additional cost to the Purchaser.

2. The contractor shall guarantee that he will design and reinstall any part of the Work for which he is responsible which fails to meet stated performance specifications during the warranty period, at no additional cost to the Purchaser.

3. Any part of the Work for which the Contractor has given approval or certification, or any equipment which the Contractor has selected for installation and installed shall be his responsibility under the terms of the Performance Guarantee.

4. The warranty period shall be for twelve (12) months after the commencement of continuous operations.

Section 6 - Description of Work

6.1 Boiler Relocation

- 6.1.1 Removal
- 6.1.2 Transport
- 6.1.3 Delivery

6.2 Stack Relocation

- 6.2.1 Removal
- 6.2.2 Transport
- 6.2.3 Delivery and installation

6.3 Mechanical Installation

- 6.3.1 Boiler and auxiliary equipment
- 6.3.2 Balanced draft system
- 6.3.3 Piping

6.4 Boiler Conversion to CWF

- 6.4.1 Modifications to boiler
- 6.4.2 Coal-water fuel burner
- 6.4.3 Coal-water fuel ignitor

6.5 Work Not Included

The scope of work is as follows: relocation of a used 60,000 lb/hr package boiler, auxiliary equipment and stack to the worksite described under General Requirements (Section 5.1); installation of the boiler, auxiliary equipment and stack; design, supply and installation of a combustion air heater and balanced draft system including all related ductwork; piping installation; modification of the boiler to burn coal water fuel and; the supply and installation of CWF burner and ignitor.

6.1 BOILER RELOCATION

The boiler to be relocated is presently situated at the AECL Heavy Water Plant in Glace Bay, N.S. and is to be relocated at Minas Basin Pulp and Power Ltd., in Hantsport, N.S.

6.1.1 REMOVAL

The Contractor will be responsible for removing the following items from the Heavy Water Plant: a package boiler as per drawing #D02 (see section 7.4), deaerator tank, blowdown tank, FD fan with housing and motor, air handling ductwork and dampers, feedwater pumps and motors, chemical mixing tank and any other parts integrally attached to the boiler except the stack (see section 6.2 - Stack Relocation). The Contractor will also be responsible for disconnection of the boiler and auxiliary equipment from any existing anchor bolts, mounting/holding brackets or ductwork that may be in place. The FD fan, housing and motor shall be removed from the boiler for transport and similarly any other equipment attached to the boiler which could endanger its safe transport.

6.1.2 TRANSPORT

The Contractor will be responsible for the supply of all vehicles and machinery required to transport the boiler and auxiliary components.

The Contractor will be responsible for loading the boiler and auxiliary equipment onto the transporting vehicles and securing same for safe transport. All equipment to be relocated is situated at the Glace Bay Heavy Water Plant. After all equipment is loaded and secured, the Contractor will transport the components to the work-site at Minas Basin Pulp and Power Ltd., in Hantsport, N.S., a distance of approximately 600 km from Glace Bay (See Section 5.1- Location of Work).

6.1.3 DELIVERY

The Contractor is required to review the site layout arrangement shown in drawing #D07 and assess its suitability in accordance with the requirements of the described work. Any proposed changes in site layout will be submitted on a separate sheet with the Tender submission showing the nature of the change and clearly stating its advantages. The Contractor will prepare a site layout drawing based on Drawing #D07 and/or the proposed changes and submit it to the Purchaser for review prior to release for construction.

The Contractor is responsible for the off-loading of all transported equipment at the Hantsport work-site and locating each major component in the position as shown on the site layout drawing. The Contractor will also be responsible for any costs incurred due to the interim storage requirements or demurrage on transport equipment and vehicles between removal and off-loading at the work-site.

6.2 STACK RELOCATION

The stack to be relocated is presently situated beside the boiler at the Glace Bay Heavy Water Plant. Considering stack relocation separate from that of the boiler will facilitate deletion of this component from the project if necessary.

6.2.1 REMOVAL

The Contractor will be responsible for removing the stack (see drawing #D08, Section 7.4) from its foundation and disconnecting any anchor bolts, supports or ductwork that may be in place.

6.2.2 TRANSPORT

The Contractor will be responsible for disassembly of the stack required in preparation for transport, loading the stack onto the transporting vehicles supplied by the Contractor and securing the same for safe transport. The stack is not to be cut into sections. After loading and securing, the Contractor will transport the stack to the MBP&P work-site, a distance of approximately 600 km. Any interim storage or demurrage costs between removal and delivery will be borne by the Contractor.

6.2.3 DELIVERY & INSTALLATION

The Contractor is responsible for the off-loading of the stack at the work-site, reassembly of any components dismantled for transport, properly orienting and locating the stack on its foundation as shown on the site layout drawing and properly securing the stack by means of anchor bolts set in the concrete of the foundation. (Foundation and anchor bolts by others.)

6.3 MECHANICAL INSTALLATION

Mechanical installation shall include the following:

6.3.1 BOILER AND AUXILIARY EQUIPMENT

The Contractor will ensure that the boiler, deaerator, blowdown tank, feedwater pumps and chemical mixing tanks are properly positioned as per the site layout drawing, adequately secured to their foundations according to any applicable codes for the installation of such equipment and that any support brackets, support structures, anchoring devices and required access platforms are fabricated and properly installed. All materials for such fabrication will be supplied by the Contractor. Any existing materials will be used where possible and which will result in a cost saving to the project.

6.3.2 BALANCED DRAFT SYSTEM

The Contractor will prepare a process and instrumentation drawing using drawing #D01 as a guide. The P & I drawing shall include all features of drawing #D01 and any changes or additions must be reviewed by the Purchaser prior to release for construction, (See Section 5.10 and 5.12.).

The Contractor will design, supply and install a balanced draft system (BDS) capable of handling the combustion air and boiler flue gas. The design will include a suitable layout scheme for the BDS components using the site layout drawing and P & I drawing as reference. The specifications required to enable proper design of essential components in the balanced draft system are given in Section 7.2- "Specifications for Balanced Draft System". The BDS shall consist of the following components: forced draft fan and motor; combustion air primary flow element; steam heater coil; tubular combustion air heater; induced draft fan and motor; all ductwork, insulation, grills, dampers, drive linkages, positioners capable of accepting a 4-20 ma process signal, gasket materials, support structures, securing devices and any other necessary hardware and supplies required to properly connect all system components to the boiler and stack in accordance with all applicable codes and regulations.

Where possible the contractor is required to make use of the existing F.D. fan, ductwork and other equipment and materials supplied which will provide the prescribed operating conditions (see Section 7.2) and result in a reduction in total project cost (see "Purchaser Supplied Equipment" Section 7.1). The tubular air heater is to be designed such that heat will be transferred from the boiler flue gas to the combustion air stream, according to the specifications described in Section 7.2.

The contractor will ensure that the induced draft fan is sized adequately to handle the pressure loss that would be introduced by the installation of a baghouse between the boiler and ID fan and that provision is made in the ductwork design which will facilitate the future addition of a baghouse if required. Also, the contractor will quote the cost (for comparison purposes) of an ID fan sized such that no provision is made for baghouse pressure loss (see Section 2 - Form of Tender, Appendix 1).

The Contractor will submit the BDS design,layout and design performance specifications to the Purchaser for review. Upon receipt of written notice of review from the Purchaser, the Contractor will supply and install the balanced draft system and ensure that its operation meets or exceeds design performance specifications. In the event that these specifications are not met during start-up due to deficiencies in the design, supply or installation of the balanced draft system, the Contractor will immediately make any modifications or replacements of BDS components that are required to meet design performance specifications during start-up, at no additional cost to the Purchaser. Design performance specifications shall be deemed to have been met or not to have been met based on readings of flow, temperature and pressure taken from such indicating devices as are located in the balanced draft system and shown on the P & I drawing.

6.3.3 PIPING

The Contractor will install the piping system which includes all piping, valves, fittings, pumps, vessels, primary flow elements, flow meters, guards, supports, expansion joints, connections and insulation, required to connect the boiler with its auxiliary equipment for safe and proper operation using the P & I drawing and the site layout drawing. The Contractor will also supply any materials, supplies and equipment required to complete the installation except for those items specified as supplied in Section 7.1- "Purchaser Supplied Equipment". The installation by the Contractor will be a field fit as per the P & I drawing and the plant layout drawing and the Contractor will ensure that:

1) installation is completed with strict adherence to all applicable codes and regulations;

2) all inspections are carried out as specified in the applicable codes and regulations and that all required inspection certificates or permits are obtained and handed over to the Purchaser;

3) any element of the piping system which is improperly installed whether discovered by the Contractor, Inspector or Purchaser, will immediately be removed and properly reinstalled, at no additional cost to the Purchaser (proper installation refers to satisfying both the requirements of the applicable codes and regulations and the general arrangements of the P & I drawing);

4) all elements of the piping system will be routed and located in such a manner as to provide tidy and efficient use of pipe and fittings and safe and adequate accessibility to system components and plant equipment;

5) all CWF piping upstream of the CWF pump (see P & I drawing #D01) shall be installed using victaulic fittings.

In addition, the Contractor must submit to the Purchaser, for review prior to commencing installation of the piping system a piping layout sketch showing the proposed routing of all necessary pipe lines and approximate location of valves. Upon receiving written notice from the Purchaser, the Contractor will proceed with installation of the piping system in accordance with the arrangement shown in the sketch.

The Contractor will cap off the existing steam heating coil located in the mud drum of the boiler in accordance with any applicable codes and regulations.

6.4 BOILER CONVERSION TO CWF

Conversion of the boiler to burn CWF will include the following:

6.4.1 MODIFICATIONS TO BOILER

The Contractor shall review the Modified Boiler drawing #D03 and the Windbox Modifications drawing #D04 and assess their suitability in accordance with the requirements of the described work. Any proposed changes to the boiler or windbox will be submitted on a separate sheet with the tender submission showing the nature of the changes and clearly stating the advantages. Note particularly, the addition of insulating material on the walls and ceiling of the combustion chamber in drawing #D04. The Contractor will prepare a Boiler/Windbox Modification drawing (or drawings) based on drawings #D03 and #D04 and/or the proposed changes and will submit it (or them) to the Purchaser for review prior to release for Construction.

The Contractor will supply and install all refractory, steel and other materials required as shown in the boiler/windbox modification drawing(s) to accommodate the CWF burner. Specifically this component of work shall comprise: removal and disposal of all existing refractory material from the front wall of the boiler; extension of the windbox and furnace draft connection; modification of the front boiler wall to accommodate the new refractory throat and burner assembly; insulation of the windbox walls; modification of the front wall of the windbox to accommodate the CWF burner; and installation of new refractory materials in the front wall of the boiler.

In addition, the Contractor will quote the cost, as a separate item in the Schedules of Prices (see Section 2-Form of Tender), of the following work element: enlargement of the viewport in the boiler rear wall to a six inch diameter size and the supply and installation of a suitable replacement viewport with shutter and removable high temperature clear glass lens.

The Contractor will ensure that the combustion air entry to the windbox is arranged such that no significant increase (above that of the exiting design) in combustion air pressure loss is introduced to the system and that the air is delivered to the windbox so as to impart a counterclockwise rotation of the air stream in the windbox. Fitting of the front end of the CWF burner assembly to the front boiler wall shall be accomplished in a manner to ensure proper alignment of windbox and front boiler wall mounting bolts and flanges.

The Contractor will also ensure that the centerline of the burner mounting hole in the windbox is properly aligned with the centerline of the burner hole in the boiler front wall. Any misalignment of these holes must immediately be rectified by the Contractor at no extra cost to the Purchaser.

Any additional structural support required for the boiler as a result of these modifications will be the responsibility of the Contractor who must submit such recommendations with the tender submission and include the cost in the quoted price.

6.4.2 COAL-WATER FUEL BURNER

The CWF burner consists of the burner air register and a CWF atomizer. The atomizer will be supplied from the National Research Council of Canada. The burner air register is a design which has been developed by Canmet and is referred to as the Canmet CWF Burner Model 1000. The Contractor will review the Canmet CWF Burner Model 1000 drawings contained in section 7.5.

All due precaution has been taken to ensure that the Canmet CWF Burner Model 1000 drawings contain sufficient detail for the Contractor's purposes. However, should the Contractor encounter any dimensional or material uncertainties during fabrication, it will be the responsibility of the Contractor to immediately bring these to the attention of the Purchaser. Any changes or additions must be reviewed by the Purchaser.

Any proposed changes to the air register will be submitted on a separate sheet with the Tender submission showing the nature of the changes and clearly stating the advantages. The Contractor will prepare air register drawings based on the Canmet CWF Burner Model 1000 drawings (reproducable drawings available from the Purchaser) and/or the proposed changes and will submit them to the Purchaser for review prior to release for Construction.

In addition to the standard 13 1/2" secondary air cone arrangement, the Contractor is required to provide a price for fabrication of the optional 14 1/2" secondary air cone arrangement (refer to drawing #'s 221341, 221251, 221261 and 221291 from Section 7.5).

The Contractor shall notify the Purchaser of the location of the shop where the air register will be fabricated and will arrange for authorization for the Purchaser to inspect the air register during fabrication and upon final assembly before packaging for shipping. Any alterations, or additions to the air register during fabrication must first be reviewed by the Purchaser.

If an inspection by the Purchaser reveals a deficiency in the fabrication of the burner air register, the contractor shall immediately make, at no additional cost to the Purchaser, any modifications, or replacement of fabricated components as necessary to remove the deficiency without introducing any additional deficiency which could adversely affect the installation and operation of the air register.

6.4.3 COAL-WATER FUEL IGNITOR

The Contractor will supply and install a propane fired ignitor capable of delivering 5 X 10^6 Btu/hr as an ignition flame for the coal-water fuel. The ignitor must be dimensionally sized to fit the air register such that it can be inserted through the 4 1/16" diameter holes on the tube housing and tube housing cover with sufficient clearance to allow a slight tilting of the ignitor towards the burner centerline, as shown in General Arrangement drawing for the air register. The ignitor shall have a minimum operating length of 44 inches and shall be supplied with a securing device which will secure the ignitor to the tube housing cover and allow the ignitor insertion depth to be varied over a range of at least 10 inches (i.e. insertion depth of from 34 to 44 inches from the tube housing cover.) Also, the Contractor will supply mounting hardware for the flame scanners.

In addition the Contractor will submit dimensional and design performance specifications of the ignitor with the tender submission including the name of the proposed supplier of the ignitor.

6.5 WORK NOT INCLUDED

The following items are not included in the scope of work for which the Contractor will be responsible:

1) Civil site preparations - all civil work including design and installation of any required foundations and supporting piles will be completed by the Purchaser. This includes removal and replacement or building of any walls to enable locating the boiler on its foundation, construction of a control room and any painting required.

2) Electrical installation - any electrical wiring of motors, positioners, starters, valves, instruments and other equipment will be the responsibility of the Purchaser. This will also include the installation of any instruments shown on the P & I drawing # D01 except primary flow elements and any other equipment integral to the piping which will be installed by the Contractor as described under description of work (Section 6).

3) CWF storage - the coal-water fuel tanks, tank enclosure and off-loading pump will be the responsibility of the Purchaser except for any piping installation as described under piping - Section 6.3.3.

4) Tie-ins - tie-in of the condensate line, HFO line, propane line, instrument air lines and softened water will be the responsibility of the Purchaser.

Section 7 - Drawings and Specifications

7.1 Purchaser Supplied Equipment

7.2 Specifications for Balanced Draft System

7.3 Boiler Data

7.4 Equipment and Installation Drawings

7.5 Canmet CWF Burner Model 1000 Drawings

7.1 PURCHASER SUPPLIED EQUIPMENT

VH02, 4" check valve, 300 lb flange connections
VH03, 1 1/2" check valve, 300 lb flange connections
VH05, 3" check valve, 300 lb flange connections
VH06, 3" check valve, 300 lb flange connections
VH01, 2" check valve, 150 lb flange connections
VH07, 1 1/2" check valve, 150 lb flange connections

VP02, 3" relief valve, 300 lb flange connections
VP03, 3" relief valve, 300 lb flange connections
VP01, 4" relief valve, 150 lb flange connections
VP04, 1 1/4" relief valve, N.P.T. connections
VP05, 1/2" relief valve, N.P.T. connections

VC02, 3" regulating valve, 300 lb flange connections
VC05, 1 1/4" regulating valve, N.P.T. connections
VC04, 2 1/2" control valve, 300 lb flange connections
VC03, 1 1/2" control valve, 300 lb flange connections
VC01, 3" control valve, 150 lb flange connections
VC07, 1" control valve, N.P.T. connections

VA05, 3" solenoid valve, 150 lb flange connections
VA08, 1 1/4" solenoid valve, N.P.T. connections
VA10, 1 1/4" solenoid valve, N.P.T. connections
VA11, 1 1/4" solenoid valve, N.P.T. connections
VA17, 3" butterfly valve, 300 lb flange connections
VA13, 1 1/2" solenoid valve, N.P.T. connections
VA14, 1 1/2" solenoid valve, N.P.T. connections
VA15, 1 1/2" solenoid valve, N.P.T. connections
VA16, 1" solenoid valve, N.P.T. connections

VS01, 3/4" ball valve, N.P.T. connections
VS02, 3/4" gate valve, N.P.T. connections
VS03, 2" gate valve, 300 lb flange connections
VS04, 1 1/2" ball valve, N.P.T. connections
VS05, 3" gate valve, 150 lb flange connections
VS06, 3" gate valve, 150 lb flange connections
VS07, 3" gate valve, 150 lb flange connections
VS08, 1/2" ball valve, N.P.T. connections
VS09, 3" gate valve, 150 lb flange connections
VS10, 3" gate valve, 150 lb flange connections
VS11, 3" gate valve, 150 lb flange connections
VS12, 1/2" ball valve, N.P.T. connections
VS13, 1/2" ball valve, N.P.T. connections
VS14, 3" gate valve, 150 lb flange connections
VS15, 4" gate valve, 300 lb flange connections
VS16, 3" gate valve, 300 lb flange connections

VS17, 3" gate valve, 300 lb flange connections
VS18, 1 1/2" gate valve, 300 lb flange connections
VS19, 1 1/2" gate valves, 300 lb flange connections
VS20, 1 1/2" gate valve, 300 lb flange connections
VS21, 1 1/2" gate valve, 300 lb flange connections
VS22, 1" ball valve, N.P.T. connections
VS23, 1/2" ball valve, N.P.T. connections
VS24, 1/2" ball valve, N.P.T. connections
VS25, 1/2" ball valve, N.P.T. connections
VS26, 1 1/2" gate valve, N.P.T. connections
VS27, 3/4" ball valve, N.P.T. connections
VS28, 3/4" ball valve, N.P.T. connections
VS29, 8" stop/check valve, 300 lb welded
VS30, 3/4" ball valve, N.P.T. connections
VS31, 6" gate valve, 300 lb flange connections
VS32, 3" gate valve, 300 lb flange connections
VS33, 3" gate valve, 300 lb flange connections
VS34, 3/4" ball valve, N.P.T. connections
VS35, 2 1/2" gate valve, 300 lb flange connections
VS36, 2 1/2" gate valve, 300 lb flange connections
VS37, 2 1/2" gate valve, 300 lb flange connections
VS38, 1 1/4" gate valve, 150 lb flange connections
VS39, 3/4" ball valve, N.P.T. connections
VS40, 1 1/2" ball valve, N.P.T. connections
VS41, 1 1/2" ball valve, N.P.T. connections
VS42, 1" ball valve, N.P.T. connections
VS43, 1" ball valve, N.P.T. connections
VS44, 1 1/4" ball valve, N.P.T. connections
VS45, 1 1/4" ball valve, N.P.T. connections
VS46, 1 1/4" ball valve, N.P.T. connections
VS47, 1 1/4" ball valve, N.P.T. connections
VS48, 1 1/2" ball valve, N.P.T. connections
VS49, 1 1/4" ball valve, N.P.T. connections
VS48, 1/2" ball valve, N.P.T. connections
VS50, 1 1/4" ball valve, N.P.T. connections
VS51, 1 1/4" ball valve, N.P.T. connections
VS52, 1 1/4" ball valve, N.P.T. connections
VS53, 1 1/4" ball valve, N.P.T. connections
VS76, 1 1/4" ball valve, N.P.T. connections
VS54, 3" butterfly valve, 300 lb flange connections
VS56, 3" butterfly valve, 300 lb flange connections
VS57, 3" butterfly valve, 300 lb flange connections
VS73, 3" butterfly valve, 300 lb flange connections
VS55, 1 1/2" ballvalve, N.P.T. connections
VS58, 1 1/2" butterfly valve, N.P.T. connections
VS59, 1 1/2" butterfly valve, N.P.T. connections
VS60, 1 1/2" butterfly valve, N.P.T. connections
VS61, 1 1/2" butterfly valve, N.P.T. connections

VS62, 1 1/2" butterfly valve, N.P.T. connections
VS65, 1 1/2" butterfly valve, N.P.T. connections
VS63, 1" ball valve, N.P.T. connections
VS64, 1 1/2" gate valve, N.P.T. connections
VS66, 1" ball valve, N.P.T. connections
VS67, 1" ball valve, N.P.T. connections
VS68, 1" ball valve, N.P.T. connections
VS69, 1" ball valve, N.P.T. connections
VS70, 2" ball valve, N.P.T. connections
VS71, 2" ball valve, N.P.T. connections
VS72, 4" butterfly valve, 300 lb flange connections
VS74, 4" butterfly valve, 300 lb flange connections
VS77, 1" ball valve, N.P.T. connections
VS78, 1" ball valve, N.P.T. connections
VS79, 1" ball valve, N.P.T. connections
VS80, 1" ball valve, N.P.T. connections
VS81, 6" gate valve, 300 lb flange connections
VS82, 2" gate valve, 300 lb flange connections
VS83, 3/4" gate valve, 300 lb flange connections
VS89, 2" gate valve, 150 lb flange connections
VS84, 1/2" ball valve, N.P.T. connections
VS85, 1/2" ball valve, N.P.T. connections
VS86, 1/2" ball valve, N.P.T. connections
VS87, 1/2" ball valve, N.P.T. connections
VS88, 1/2" ball valve, N.P.T. connections
VS91, 1/2" ball valve, N.P.T. connections
VS90, 1/2" ball valve, N.P.T. connections
VS92, 4" butterfly valve, 300 lb flange connections

Fuel flowmeter, 1 1/2", 300 lb flange connections
Chemical flowmeter, 1/4", N.P.T. connections

Boiler feedwater flowelement, 2 1/2", 300 lb flange connections
Deaerator feedwater flowelement, 3", 150 lb flange connections
Steam flow in header, 6", 300 lb flange connections
Steam to deaerator flowelement, 3", 150 lb flange connections

Exhaust gas, heater inlet, thermowell, 3/4" N.P.T.
Exhaust gas, heater outlet, thermowell, 3/4" N.P.T.
Combustion air, heater inlet, thermowell, 3/4" N.P.T.
Combustion air, heater outlet, thermowell, 3/4" N.P.T.

Pressure element #1 ON CWF, 300 lb flange connections, 3"
Pressure element #2 ON CWF, 300 lb flange connections. 3"

Coal water fuel pump, 300 lb flange connector, 3"
Chemical metering pump, N.P.T. connection, 1/2"
Feed water pump 1, 300 lb flange connections, 2" outlet, 3" inlet

Feed water pump 2, 300 lb flange connections, 2" outlet, 3" inlet
Forced draft fan with motor
Forced draft damper
I.D. damper
Chemical tank with agitator
Flowmeter on oil (150 lb flange connections), 1"
Deaerator
Blowdown tank
Rupture disc on CWF, 150 lb flange connections, 1 1/2"
Stack
Strainers for CWF, 3", 150 lb flange
CWF storage tanks
Low flow element on CWF, 3", 190 lb flange
Main flame scanner
Secondary flame scanner
Combustion air flow annubar, to be installed in duct

7.2 Specifications for Balanced Draft System

The balanced draft system must be capable of meeting the following performance specifications:

HFO firing of boiler at 100% MCR

- combustion product rate	71,500 lb/hr.
- combustion air required	67,000 lb/hr.
- particulate loading in flue gas	$<0.10 \frac{\text{grains}}{\text{SCF}}$
- excess air in exhaust gas	10-20%
- exhaust gas temperature at boiler outlet (boiler design temp.)	600 F
- minimum allowable flue gas temperature entering stack	375 F
- burner air resistance	10 in. W.C. (max.)
- combustion air temp. at FD fan	90 F
- combustion air temp required at windbox	90 F

CWF Firing of Boiler at 4762 lb/hr Coal Water Fuel Firing Rate, 10% excess air

- boiler thermal input (nominal)	50 MM Btu/hr.
- combustion product rate	47,191 lb/hr.
- combustion air required	42,429 lb/hr.
- particulate loading in flue gas	$0.62 \frac{\text{grains}}{\text{SCF}}$
- required range of excess air in exhaust gas	10-20%
- min. exhaust gas temperature at boiler outlet	500 F
- minimum allowable flue gas temp. entering stack	375 F
- burner air resistance	10 in. W.C. (max.)
- combustion air temp at FD fan	90 F
- min. combustion air temp required in windbox	400 F

In addition, draft balance point is to be inside furnace and shall be 0 in W.C. A copy of coal-water fuel specifications is attached. For information on boiler data and forced draft fan curve see Section 7.3.

Carbofuel Specifications

From CBDC Harbour Seam Coal

		Typical
1.	Promimate - Dry Basis	
	Ash %	1.7
	Sulphur %	0.9
	Volatile %	37.0
2.	Ultimate (Dry Ash Free)	
	Carbon	87.0
	Hydrogen	5.8
	Nitrogen	1.3
	Sulphur	.9
	Oxygen	5.0
	Ash Fusion (Oxidizing Mode)	1432 C (ST)
3.	Heating Value - Dry Basis	
	BTU per pound (dry)	15,000
	BTU per pound (as received)	10,500
	Kilojoules/kg	35,000
4.	Specific Gravity	
		_1.15
5.	Water Content %	
		30.0
6.	Viscosity (cp)	
	At 25.6 Sec. -1 Shear Rate	1000
	Viscosity decrease from that at 75 sec. -1 to that at 452 sec. -1 when shear rate is increased from Zero at 452 sec. -1 over 2.24 minutes	300
	(Viscosity measurements by Contraves Rheomat 115)	
7.	Particle Top Size - Microns	
	Maximum Particle Size	250

7.3 Boiler Data

Original Manufacturer	B&W Canada Ltd.
Boiler Steam Rating	60,000 lb/hr
Boiler Type	Package, Membrane Wall
Boiler Dry Weight	78,000 lb.
Boiler Horsepower	400 HP
Design Pressure	250 psig
Operating Pressure	150 psig
Heating Surface - Boiler	3402 ft^2
Furnace	670 ft^2
Furnace Volume	1395 ft^3
F.D. Fan	Centrifugal, fan curve attached
Fan Motor Horsepower	60 HP 550 v

Boiler Design Performance Specifications on light oil at 100% MCR:

Flue gas exit temperature	600 F
Flue gas leaving boiler	71,500 lb/hr.
Combustion air	67,300 lb/hr.
Excess air leaving boiler	10%
Furnace heat liberation	58.5 MMBTU/hr.
Boiler draft loss	4.9 in. w.c.
Existing burner and windbox draft loss	7.3 in. w.c.
Max. allowable boiler feedwater concentration	3500 ppm solids

7.4 Equipment and Installation Drawings

- #D01 - Process and Instrumentation drawing
- #D02 - Original boiler drawing
- #D03 - Modified boiler drawing
- #D04 - Boiler front modifications drawing
- #D05 - Deaerator drawing
- #D06 - Blowdown Tank drawing
- #D07 - Site Layout drawing
- #D08 - Stack drawing

7.5 - Canmet CWF Burner Model 1000 Drawings

018390 - General Arrangement

018400 - Plate Steel Body

221231 - Burner Shell & Lifting Jig

221341 - Plate Steel Cones

221251 - Air Swirlers

221261 - Primary Air Ducts

221271 - Air Vane Assembly

221281 - Primary Air Cut-Off Sleeve

221291 - Burner Tube Assembly

221301 - Primary Air Entry Duct

221311 - Secondary Air Sleeve

605063 - Outer Face Cover

APPENDIX C

PROGRESS REPORTS

MINAS BASIN PULP & POWER

CWF CONVERSION

PROJECT REPORT #1

1987-09-30

DISTRIBUTION

MEMBERS OF STEERING COMMITTEE

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Kelly Thambimuthu, CANMET
Phil Read, Energy, Mines & Resources, Canada
Audbrey Palmeter, Minas Basin Pulp & Power Co. Ltd.
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Lorne MacNeil, Canada-N.S. Oil Substitution Fund
Adrian White, Cape Breton Development Corporation

Prepared by:

Robert Kazmel
Joel MacLean

As noted during the first steering committee meeting of 1987-08-13, J.W. Lindsay Enterprises Ltd. has been awarded the CWF site preparation contract by Minas Pulp & Power Ltd. Lindsay in turn has subcontracted the foundation design work to George Brandy's & Associated. Since that time, two (2) project meetings have taken place with Lindsay representatives.

The expected cost overrides on the civil work include:

1. Base for ID fan - this information was not provided on the original plan by MBB - estimated cost is: $5,000.00.

2. MBB has requested that the stack base height be level with the finished floor, not at finished grade - estimated cost: $3,000.00.

3. Floor drains and oil separator for the boiler room floor along with a sump in the CWF storage pit - estimated cost: $2,000.00.

4. Jacques Whitford to supply a soils engineer - estimated cost: $3,000.00.

5. CWF effluent line relocation - estimated cost: $12,000.00.

Expected cost overrides for the civil site preparation is approximately: $25,000.00.

The estimated time required for the civil site preparation is seven (7) weeks including two (2) week minimum to cure.

The Cape Breton Development Corporation issued a purchase order for the AECL boiler on 1987-05-08. The purchased items were:

1. Steam generator including FD fan;

2. blow off tank;

3. boiler stack;

4. two (2) feedwater pumps and motors;

5. deaerator;

6. chemical mix tank;

7. chemical mixer.

Due to a request by Nova Aqua, (the company holding a lease on the AECL building in which the boiler was housed), the boiler was removed for its footings ahead of schedule. The cost extra for the early removal was $4,666.00. Minas Basin has purchased two

(2) used 12 X 20 ft. CWF storage tanks. At the time of writing not cost has been supplied to CBDC for these tanks.

On 1987-09-14 MBB Mechanical started dismantling and preparing for transport the boiler, stack and auxiliary equipment. The boiler is are currently sitting on a CN flat bed at the AECL site. The stack was shipped by road to Minas on 1987-09-15 and the boiler auxiliary equipment arrived at Five Islands on 1987-09-24.

On 1987-09-23 Minas removed the underground day tank and Lindsay were to commence excavation.

Currently, all materials required to operate and control the boiler are ordered and some materials have been received. For the control system, we have taken delivery of the necessary computer hardware, the PCW/LAN90 software from Bailey and the QNX operating system from Quantum.

An initial draft of the modulating control configuration required for the COM03 control modules on the network 90 have been developed. The final analog configuration will be determined after consultation with Bailey. This consultation is necessary, since the logic control that Bailey is developing and the modulating controls that are developing have some common points.

The QNX operating system has been booted on two (2) computers and we are currently experimenting with modern communications and file transfer methods available on QNX. We are also developing the configuration of the PCW/LAN90 software.

On 1987-09-15 representatives of Canmet, NRC and MBB attended a project meeting. The purpose of which was:

1. Review of Canmet/NRC burner performance at MECL.

2. Discussion of changes to burner design for application in Minas Basin.

3. Review of Minas Basin project schedule.

Minor modifications to the original piping arrangements have been made and these have been relayed to MBB Mechanical.

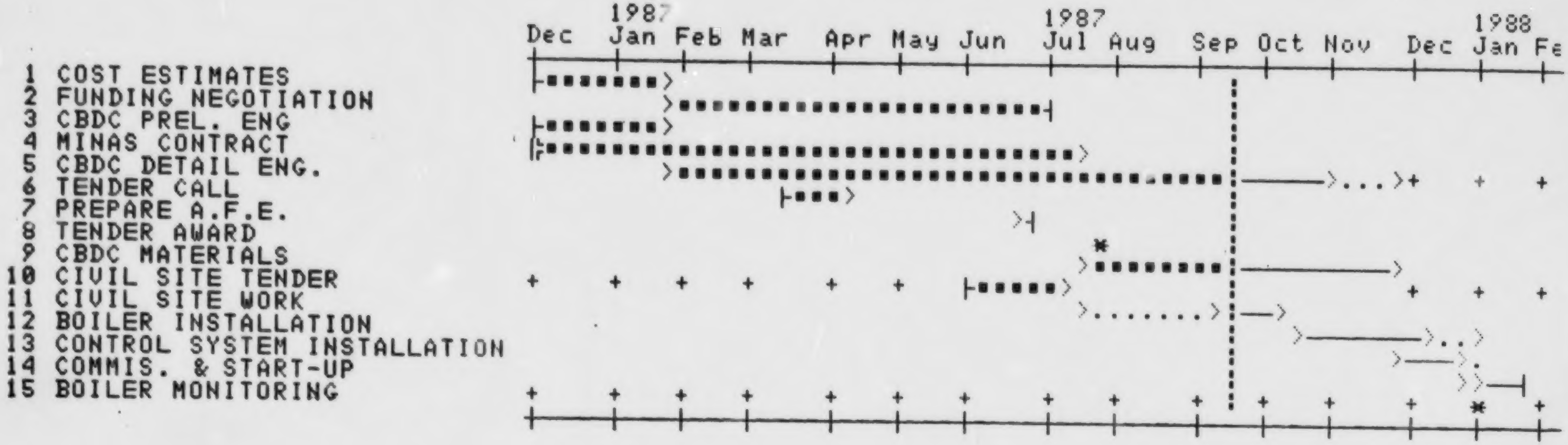
Commitments to date include:

1.	J.W. Lindsay Enterprises Ltd.	$105,188.00
2.	MBB Mechanical Services	$446,557.00
3.	CBDC supplied equipment	$296,440.44

4.	Minas supplied equipment	Not Available
	Total to date	$848,185.44
	Contract changes to date	$ 30,366.00

Attached you will find project schedule and project budget.

MINAS CWF CONVERSION PROJECT
SEPT. 24 1987



CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.	EST. TO CO
11	FOUNDATION/STACK & FANS	30000	15620	15620	0	15620	0	0
12	BOILER HOUSE / FOUNDATION	55000	90568	89568	1000	89568	0	0
13	CONTROL ROOM A/C	5000	8000	8000	0	0	0	8000
14	PAINTING MAT/LAB	2500	7000	7000	0	0	0	7000
10 .	CIVIL SITE PREPARATION	92500	121188	120188	1000	105188	0	15000
21	BOILER PURCHASE	60000	60000	60000	0	60000	0	0
22	STACK REMOVAL	2000	6025	6025	0	6025	0	0
23	STACK TRANSPORT	1000	880	880	0	880	0	0
24	STACK INSTALLATION	6000	8200	8200	0	8200	0	0
25	BOILER REMOVAL	12000	33791	38457	-4666	33791	0	4666
26	BOILER TRANSPORT	7000	6680	6680	0	6680	0	0
27	BOILER INSTALLATION	44000	52208	52890	-682	52890	0	0
28	MECHANICAL MATERIALS	10000	50131	50130.1	0.9	50130.15	0	-0.05
29	MECHANICAL INSTALLATION	46000	34226	34226	0	34226	0	0
30	CONDENSATE RETURN SYSTEM	0	11100	11100	0	0	0	11100
31	BOILER FEED SOFTENER	0	15000	15000	0	0	0	15000
32	P & I ENGINEERING	0	1128	1128	0	1128	0	0
33	VIEW PORT ENLARGEMENT	0	500	500	0	500	0	0
20	BOILER	128000	279869	285216.1	-5347.1	254450.15	0	30765.95

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.	EST. TO CO
41	CWF STORAGE TANK	30000	20000	20000	0	0	0	20000
42	CWF PIPING MATERIALS	10000	3130	3130	0	3130	0	0
43	CWF PIPING INSTALLATION	13000	7930	7930	0	7930	0	0
44	CWF OFF-LOADING PUMP	10000	5000	5000	0	0	0	5000
45	CWF TRANSFER PUMP	15000	15000	15000	0	14425	0	575
46	HFO SET	0	20000	20000	0	0	0	20000
47	HFO PIPING MATERIALS/INST.	0	10000	10000	0	0	0	10000
40	FUEL HANDLING SYSTEM	78000	81060	81060	0	25485	0	55575
51	CWF ATOMIZER (NRC)	18000	12000	12000	0	12000	0	0
52	HFO ATOMIZER	0	12000	12000	0	0	0	12000
53	CWF BURNER FABRICATION	24000	13955	13955	0	13955	0	0
54	BURNER INST. STRUCTURAL MODS.	22000	13264	13264	0	13264	0	0
55	BURNER INST. REFRACTORY MODS.	30000	19151	19151	0	19151	0	0
56	BURNER INSTALLATION	2000	1080	1080	0	1080	0	0
57	CWF IGNITOR	7000	2750	2750	0	2750	0	0
58	BALANCE DRAFT DESIGN	3000	10080	10080	0	10080	0	0
59	BALANCE DRAFT DUCTWORK	10000	47000	47000	0	47000	0	0
60	BALANCE DRAFT INSTALLATION	7000	64917	64917	0	64917	0	0
61	AIR HEATER	40000	52452	52452	0	52452	0	0
62	ID FAN	0	37500	37500	0	37500	0	0
63	STEAM COIL AIR HEATER	0	12016	12016	0	12016	0	0
64	VIEW PORT	1200	900	900	0	900	0	0
50	CWF BURNER	164200	299065	299065	0	287065	0	12000

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.	EST. TO CO
71	COMPUTER/CONTROL SYSTEM	99000	109814	110341	-527	110341	0	0
72	TRANSMITTERS FLOW ELEMENTS	30000	24626	24626	0	24559	0	67
73	MAGNETIC FLOWMETER	6000	8228	8228	0	5736	0	2492
74	CONTROL VALVES,POSITIONERS	18000	7955	7955	0	7955	0	0
75	AUTO VALVES.PI'S.TI'S.ETC.	20000	12000	12000	0	11043.29	0	956.71
76	ELECTRICAL CABLE TRAYS	5000	2000	2000	0	0	0	2000
77	SUPPLY & INST. MAIN POWER	10000	14000	14000	0	7108	0	6892
78	FLAME SCANNER	0	2947	2947	0	2947	0	0
79	CHEMICAL METERING PUMP	0	3174	3174	0	3174	0	0
80	E & I INSTALLATION	0	12000	12000	0	0	0	12000
70	ELECTRICAL INSTRUMENTATION	188000	196744	197271	-527	172863.29	0	24407.71
90	BONDING.PERMITS,CERTIFICATS	0	3134	3134	0	3134	0	0
100	PROJECT CONTINGENCY	68900	28000	0	28000	0	0	0
110	CAPITAL RECOVERY	0	0	0	0	N/A	0	0
TOTAL		779600	1009060	985934.1	23125.9	848185.44	0	137748.66

MINAS BASIN PULP & POWER

CWF CONVERSION

PROJECT REPORT #2

1987-10-30

DISTRIBUTION

MEMBERS OF STEERING COMMITTEE

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Kelly Thambimuthu, Canmet
Phil Read, Energy, Mines & Resources, Canada
Aubrey Palmeter, Minas Basin Pulp & Power Co. Ltd.
Lorne MacNeil, Canada-N.S. Oil Substitution Fund
Adrian White, Cape Breton Development Corporation

Prepared by:

Robert Kazmel
Joel MacLean

Lanthier Construction arrived on site 1987-10-02. The first order of business was to relocate the CKF effluent line, while doing so three unidentified lines along with a fire water line were uncovered. Tie-in to the CKF line was completed on Sunday, 1987-10-04. While installing the new effluent line the contractor intersected the tie backs and the dead men for the retaining wall some 14 ft. back from the main wall, minor repairs were required.

On 1987-10-04 it was decided to relocate the fire water line since it was determined that it would fall some 3 in. below the building footings.

The excavation in the area of the old day tank was completed on 1987-10-04. A solid base was reached after removing some 19 ft. of wood chips and landfill material; back filling of this area was completed on 1987-10-06.

Excavation in the back corner of the new boiler just under the proposed [illegible] tank resulted in the need to remove some 25 ft. of overburden without being able to achieve a solid base.

A meeting was called for the following day, attendees at that meeting included: Bill Sutherland, of Jacques Whitford; Paul Robinson, of George Brandy; Peter Zwicker, of Minas Basin Pulp & Power; and Robert Kazmel, of Cape Breton Development Corp. Just prior to holding the meeting on 1987-10-07 a trench was opened between the retaining wall and the back of the new boiler house to identify whether or not a solid base could be reached, results were negative and the decision was made to redesign the foundations to accommodate a piled footing.

While excavating near the location of FD fan and air heater on 1987-10-07 an old CKF 15 in. effluent line was intersected. All drain lines in the #6 boiler house were serviced by this line; as a result, all lines were re-routed and the main 15 in. line was removed. Excavation and backfill of this area was completed on 1987-10-08.

Relocation of the fire water line was started on 1987-10-08 and was completed on 1987-10-09. Problems were encountered with a passing isolation valve which resulted in the line being pressured up before being back filled, this caused damage to one of the thrust blocks and necessitated its replacement.

Repairs to a previously damaged underground electrical cable was made on Sunday, 1987-10-09, this line was damaged on 1987-10-07 while excavating in the areas of the proposed CWF storage tanks.

Excavation beneath the proposed CWF tanks resumed on 1987-10-13 and was completed on 1987-10-15. The final depth reached was 25 ft. After consultation with both Bill Sutherland and Paul Robinson, the decision was made to change the slope requirement from 1:1 to 2:1. If the 1:1 slope had been followed, the previously relocated CKF effluent line would have to be moved back some 10 ft.

Seventeen feet of structural fill was used in this area, of this 9 ft. of surge material was used as a base.

Fourteen HP 8x36-50 steel piles arrived on 1987-10-15 and Petrifond were on site late the following day. Pile driving commenced on 1987-10-17 and was completed 1987-10-20. Pile depths are as follows:

Pile #	Depth	Pile #	Depth
1	40 ft. 2 in.	11	42 ft. 8 in.
2	40 ft. 9 in.	12	39 ft. 5 in.
3	39 ft. 11 in.	13	41 ft. 2 in.
4	40 ft. 0 in.	14	39 ft. 2 in.
5	39 ft. 0 in.	15	64 ft. 3 in.
6	40 ft. 1 in.	16	39 ft. 5 in.
7	40 ft. 4 in.	17	39 ft. 0 in.
8	40 ft. 0 in.	18	41 ft. 5 in.
9	39 ft. 11 in.	19	74 ft. 5 in.
10	35 ft. 6 in.	20	41 ft. 0 in.

The sub-contractor, Saleway Construction, had been contracted by J.W. Lindsay to do the foundations arrived on site 1987-10-16 by month's end all foundations had been completed with the exception of the pile caps and posts for the boiler along with the base of both the ID fan and the stack. The pile caps for both the ID fan and stack were poured on 1987-10-27.

MBB Mechanical Services

A project review meeting was conducted on 1987-10-21 at the offices of MBB Mechanical Services. Attendees included: Gordon Brenton, of Minas Basin Pulp & Power; Dave Lawrence of MBB Mechanical Services; Joel MacLean, of Cape Breton Development Corp. and Robert Kazmel, of Cape Breton Development Corp.

Topics covered included:

1. project schedule review;

2. R&D drawing review and revision;

3. air heater drawing review;

4. request for quotes for two HFO atomizers, two CWF strainers and workbench;

5. a complete review of MBB work to date.

By month's end all material had arrived for the fabrication of the air heater. Fabrication commenced on 1987-10-26 and is scheduled to be completed by 1987-11-05.

Burner Management and Control

Configuration of the burner management and analog controls is currently underway and will be completed by 1987-11-01. A pre-delivery checkout will be carried out in Burlington, Ontario, and delivery is expected by the second week of November. Final system checkout and tuning will be carried out after installation.

Some minor modifications to the process have been made after consultation with Minas and MBB. The modifications require the addition of four (4) manual ball valves at a total cost of $100. Also, the motor control center has been modified in order to accommodate a larger ID fan (sized for baghouse). The main breaker has been increased to 600 amps and the ID fan starter sized for 150 hp.

Termination wiring diagrams for the controls are currently being drawn using the Autocad System. The motor control wiring cannot be completed until starter control circuit wiring is received from Harris and Roome, (delivery overdue).

The majority of the equipment deliveries are anticipated by 1987-11-01, with some delays expected on the manual gate valves and the main steam stop/check valve. Although delivery is expected by the second week of November a firm date has not been given. Computer system configuration is well underway and will be completed during November.

Budget Variance Analysis

Cost Overruns - To Date

Civil Site Preparation As of 1987-10-30

1.	Base for ID fan	$ 3,520	
2.	Stack base elevated	1,488	
3.	Floor drains and ok separator	2,517	
4.	Jacques Whitford Soils Engineer	3,000	(est.)
5.	CKF effluent line relocation	13,950	
6.	Drain line from blowdown sump	3,000	(est.)
7.	Relocate fire water line	7,130	
8.	Piles for stack, ID fan and boiler	23,800	
9.	Extra 358 ft. of piles x $40/ft.	14,320	(est.)
	Sub Total	$ 72,725	

Boiler

10.	Pre-removal of boiler	4,666	
11.	CN flat bed demurrage	700	
	Sub Total	$ 5,366	
	Grand Total To Date	$ 78,091	

The cost to Minas for the purchasing of two coal-water fuel tanks was $9,000 ($4,500 each); this does not include cleaning and painting of the tanks. The budget amount is $20,000 leaving a favorable variance to date of $11,000.

The heavy fuel oil set has been purchased by Minas. This is a used set purchased from Dalhousie University, the cost to Minas was $3,500. This price does not include removal of the set from its current location. MBB Mechanical Services have been contacted by Minas to remove the set, at the time of writing no price has been quoted for the removal. The budgeted amount for the OK set is $20,000, resulting in a favorable variance to date of $16,500.

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
11	FOUNDATION/STACK & FANS	30000	15620	60248	-44628	15620	0
12	BOILER HOUSE / FOUNDATION	55000	90568	117665	-27097	89568	0
13	CONTROL ROOM A/C	5000	8000	8000	0	0	0
14	PAINTING MAT/LAB	2500	7000	7000	0	0	0
10	CIVIL SITE PREPARATION	92500	121188	192913	-71725 ✓	105188	0
21	BOILER PURCHASE	60000	60000	60000	0	60000	0
22	STACK REMOVAL	2000	6025	6025	0	6025	0
23	STACK TRANSPORT	1000	880	880	0	880	0
24	STACK INSTALLATION	6000	8200	8200	0	8200	0
25	BOILER REMOVAL	12000	33791	38457	-4666	33791	0
26	BOILER TRANSPORT	7000	6680	6680	0	6680	0
27	BOILER INSTALLATION	44000	52208	52890	-682	52890	0
28	MECHANICAL MATERIALS	10000	50131	50130.1	0.9	50130.15	0
29	MECHANICAL INSTALLATION	46000	34226	34226	0	34226	0
30	CONDENSATE RETURN SYSTEM	0	11100	11100	0	0	0
31	BOILER FEED SOFTENER	0	15000	15000	0	0	0
32	P & I ENGINEERING	0	1128	1128	0	1128	0
33	VIEW PORT ENLARGEMENT	0	500	500	0	500	0
20	BOILER	188000	279869	285216.1	-5347.1 ✓	254450.15	0

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
41	CWF STORAGE TANK	30000	20000	20000	0	0	0
42	CWF PIPING MATERIALS	10000	3130	3130	0	3130	0
43	CWF PIPING INSTALLATION	13000	7930	7930	0	7930	0
44	CWF OFF-LOADING PUMP	10000	5000	5000	0	0	0
45	CWF TRANSFER PUMP	15000	15000	15000	0	14425	0
46	HFO SET	0	20000	3500	16500	3500	0
47 -	HFO PIPING MATERIALS/INST.	0	10000	10000	0	0	0
40	FUEL HANDLING SYSTEM	78000	81060	64560	16500	28985	0
51	CWF ATOMIZER (NRC)	18000	12000	12000	0	12000	0
52	HFO ATOMIZER	0	12000	12000	0	0	0
53	CWF BURNER FABRICATION	24000	13955	13955	0	13955	0
54	BURNER INST. STRUCTURAL MODS.	22000	13264	13264	0	13264	0
55	BURNER INST. REFRACTORY MODS.	30000	19151	19151	0	19151	0
56	BURNER INSTALLATION	2000	1080	1080	0	1080	0
57	CWF IGNITOR	7000	2750	2750	0	2750	0
58	BALANCE DRAFT DESIGN	3000	10080	10080	0	10080	0
59	BALANCE DRAFT DUCTWORK	10000	47000	47000	0	47000	0
60	BALANCE DRAFT INSTALLATION	7000	64917	64917	0	64917	0
61	AIR HEATER	40000	52452	52452	0	52452	0
62	ID FAN	0	37500	37500	0	37500	0
63	STEAM COIL AIR HEATER	0	12016	12016	0	12016	0
64	VIEW PORT	1200	900	900	0	900	0
50	CWF BURNER	164200	299065	299065	0	287065	0

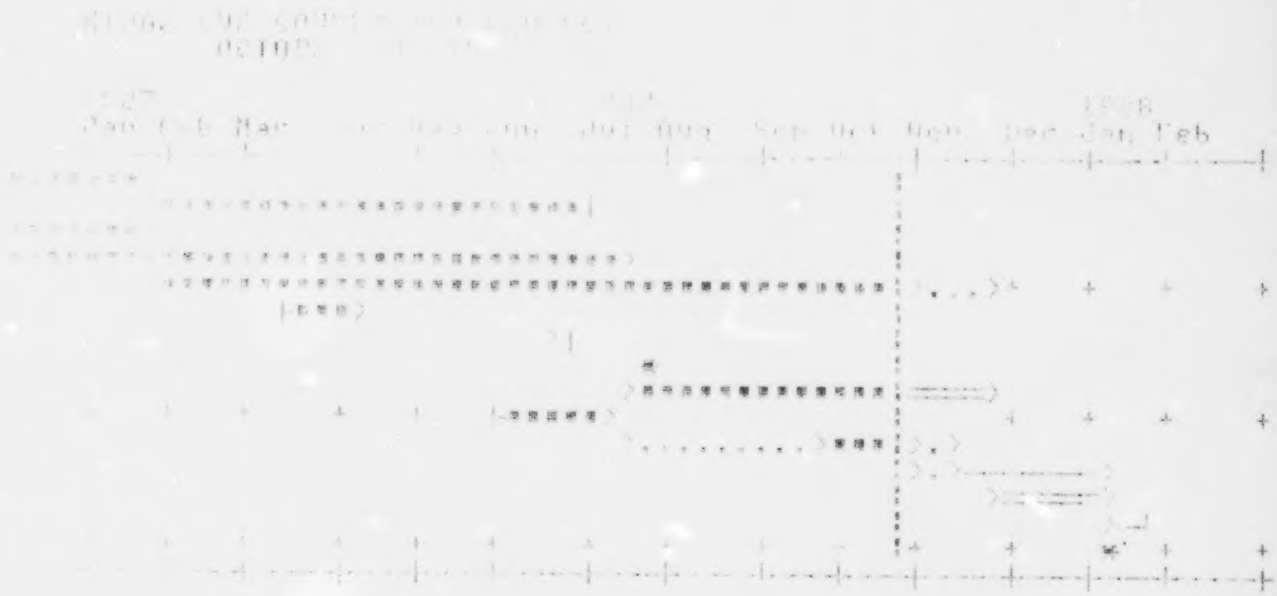
CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
71	COMPUTER/CONTROL SYSTEM	99000	109814	110341	-527	110341	0
72	TRANSMITTERS FLOW ELEMENTS	30000	24626	24626	0	24559	0
73	MAGNETIC FLOWMETER	6000	8228	8228	0	5736	0
74	CONTROL VALVES,POSITIONERS	18000	7955	7955	0	7955	0
75	AUTO VALVES,PI'S,TI'S,ETC.	20000	12000	12000	0	11063.29	0
76	ELECTRICAL CABLE TRAYS	5000	2000	2000	0	0	0
77	SUPPLY & INST. MAIN POWER	10000	14000	14000	0	7108	0
78	FLAME SCANNER	0	2947	2947	0	2947	0
79	CHEMICAL METERING PUMP	0	3174	3174	0	3174	0
80	E & I INSTALLATION	0	12000	12000	0	0	0
70	ELECTRICAL INSTRUMENTATION	188000	196744	197271	-527	172883.29	0
90	BONDING,PERMITS,CERTIFICATS	0	3134	3134	0	3134	0
100	PROJECT CONTINGENCY	68900	28000	0	28000	0	0
110	CAPITAL RECOVERY	0	0	0	0	N/A	0
TOTAL		779600	1009060	1042159.1	-33099.1	851685.44	0


1968
Jan Feb Mar May Jun Jul Aug Sep Oct Nov Dec Jan Feb

Activity Screen Symbols

Microsoft Project uses these symbols to display your project's schedule in the Gantt chart on the Activity screen. The symbols may be graphic or nongraphic, depending on your computer. Printouts may be graphic or nongraphic, depending on your printer.

Graphics Symbol	Nongraphics Symbol	Meaning
╠	0	Start of a critical activity with no predecessors.
├	0	Start of a noncritical activity with no predecessors.
)	>	Start of an activity with predecessors, or end of an activity with successors. These symbols will appear in bold face when the activity is on the critical path.
╣	x	End of a critical activity with no successors.
┤	x	End of a noncritical activity with no successors.
*	•	Milestone (no duration).
═══	=====	Critical path.
·····	····o	Slack time.
───	-----	Not on critical path.
¦	⋮	Current date.
▮▮▮)	†	Activities or percent of activities that are completed according to the current date.

Symbols that represent activities on the critical path appear bolder than symbols for noncritical activities.

MINAS BASIN PULP & POWER

CWF CONVERSION

PROJECT REPORT #3

1987-11-30

DISTRIBUTION

MEMBERS OF STEERING COMMITTEE

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Kelly Thambimuthu, Canmet
Phil Read, Energy, Mines & Resources, Canada
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Lorne MacNeil, Canada-N.S. Oil Substitution Fund
Adrian White, Cape Breton Development Corporation

Prepared by:

Robert Kazmel
Joel MacLean

Significant Events

Saloway Construction, the sub-contractor, who has been contracted by J.W. Lindsay, commenced pouring the pile caps for the boiler along with placement of the reinforcing steel for the stack base on 1987-11-02.

The N.S. Dept. of the Environment requested information on the Canmet 1000 air register and the NRC atomizer. Information supplied by Dr. Kelly Thambimuthu was forwarded to Dave Gates, of the N.S. Dept. of Environment. (See attached info.)

Because of the problems encountered while setting the stack anchor bolts in the pile cap, the decision was made to install sway pipes in the top three feet of the stack base. This would allow some movement of the anchor bolts during placement of the stack. The stack base was poured on 1987-11-03.

MBB requested that the floor beneath the deaerator tank be dropped by two feet to allow for proper suction head for the two boiler feed water tanks.

Two project meetings were held at the Minas site on 1987-11-04, one in the morning with the Minas mechanical personnel, the second in the afternoon with their electrical and instrumentation personnel. The purpose of this meeting was to:

1. review the boiler layout drawings;

2. review the process and instrumentation drawings;

3. review the Minas tie-in responsibilities.

A list of responsibilities has been prepared and was reviewed with both groups. The list of responsibilities is as follows:

1. Installation of the new oil set including running of lines up to the new boiler. The oil set has been purchased from Dalhousie University and will be installed downstairs beside the #3 wood boiler. The small existing set will be removed from this location.

2. Installation of a new water softener including a boiler feed water tank. The tank is being fabricated by Arches Welding of Minas Basin and will be placed in the same location as the water softener -(where the old compressors are currently located.) The compressors are to be removed and the building made ready as soon as possible. Controls have yet to be ordered for the tank.

3. A new control room is to be fabricated in the front corner of the new boiler house. The control room will be equipped with an air conditioner.

4. Cleaning and painting of the coal-water fuel tanks along with the boiler stack. This work is already underway.

5. Peter Zwicker to look into larger propane tank. The tank can be located behind the new boiler house. A new propane line will be run up to the boiler front.

6. Relocate existing vent and relief line on the #6 boiler deaerator. Two stack cable support brackets will also be relocated.

7. A doorway is to be opened up between the #6 boiler room and the new boiler house. The door will be located where the second window from the front is currently located. The existing line along the floor will also be required to be relocated.

8. All of the existing drain lines from the #6 boiler room need to be relocated.

9. Extend the existing eight inch steam header from the basement up to the new boiler house to allow for tie-in of the new boiler. Peter Zwicker has asked MBB Mechanical Services to quote on this piece of work. Tie-in to the new steam header will be made over the Christmas vacation period.

10. The new MCC room will be located in the room just in front of the #3 boiler. More repairs are needed before installation of the MCC. The Bailey control panels will also be located in this room.

11. Paint the stack while it is still on the ground. This work, for the most part, has been completed with the exception of the ten foot extension and the underside of the stack.

12. A condensate return line will be run to the new deaerator. A tie-in will also be extended to the #6 boiler deaerator.

13. It is Minas' responsibility to complete all boiler tie-ins, i.e.: steam, water, oil and propane, the coal-water fuel tie-in is the responsibility of MBB Mechanical Services.

14. Minas is responsible to provide adequate lighting for the new boiler house along with temporary heating prior to the boiler start-up.

On 1987-11-04 Saleway Construction finished pouring the foundation walls along the boiler front and side wall. The piles to the boiler supports were also completed. Lanthier Construction started back filling of the foundation walls and the plumbers were on hand completing the drain line tie-ins.

The boiler blowdown tank was inspected on 1987-11-05 and it was determined that it was unusable. Quotes went out the following day for a replacement tank. The quotes range from $10,500 and four weeks delivery to $18,200 and eight weeks delivery. Gordon Brenton is looking into the possibility of obtaining a used blowdown tank from Dalhousie University.

Backfilling of the main boiler house floor commenced on 1987-11-06 along with pouring of the floor beneath the coal-water fuel tank location.

The sump beneath the deaerator was completed on 1987-11-10 and the main boiler room floor was poured the following day.

Word was received on 1987-11-10 from the supplier of the steam stop check valve that their best delivery date would be in the later part of January, 1988. The decision was made to send the old valve off to Mobile Valves, in Dartmouth, for overhall and testing.

A Project Steering Committee meeting was held on 1987-11-18. (for details see meeting minutes).

MBB Mechanical Services personnel were on hand at the Minas site on 1987-11-23 to commence installation of the support systems for the boiler auxiliary equipment and to make the necessary modifications to the stack base.

The boiler arrived at the Minas site during the evening of 1987-11-24.

A project meeting was held at the MBB Mechanical Services office on 1987-11-25. Representatives for MBB, Minas, NRC, Canmet and CBDC were on hand to discuss and finalize the necessary changes which will be made to the Canmet 1000 burner.

The air heater fabrication was completed on 1987-11-25.

The boiler and air heater were placed on their footing on 1987-11-30.

A meeting was held at the N.S. Dept. of Mines & Energy offices to update Dave Gates, of the N.S. Dept. of Environment, on the project. Attendees were Ed Bain, Peter Zwicker and David Gates.

Electrical Instrumentation

Termination wiring diagrams for the Bailey Control System have been completed on the CAD System, along with terminations for each of the 20 analog transmitters. Termination drawings for the automatic valves, control valves and safety switches must still be completed.

Six of the analog transmitters require re-calibration because of the changes in design (flows, temperatures, etc.) since our original order. These re-calibrations will be completed by CBDC personnel prior to forwarding the transmitters to Minas Basin.

The motor control center has been completed, along with the associated wiring diagrams. These have been forwarded to Minas Basin personnel.

Computers

Computer configuration is complete, but still requires some review and testing. The system consists of 12 group displays of various controllers, switches, etc., which allow for boiler control; six trend displays which show 24 hour line graphs of different variables such as steam flow, air flow, etc., eight log reports, which range from daily summaries to hour-by-hour detailed reports and two graphic overviews which display live data such as valve positions, pump status, analog values, etc. In addition, the system has open windows, which can be used for other task while the control system is running.

There are three levels of security which have been added to the system. The highest level allows complete access to all software, including starting and stopping of the control system software. The second level allows reading of most files on the system, but does not permit writing. The second level cannot start the control system. The first level has access only to the control software, including logs, but cannot normally access anything else. Each level is secured by password.

Equipment Deliveries

In terms of equipment deliveries, we are approximately 98% complete. We are awaiting deliveries of two automatic valves, six gate valves, one stop/check valve, two pressure gauges, two safety switches and the oxygen analyzer. All deliveries, with the exception of the steam stop/check valve, are anticipated by the first week of December.

In addition to the equipment, we are awaiting delivery of various manuals and documentation required for different pieces of equipment. Deliveries are expected by the first week of December.

Other

A project payment report was finalized and issued to both MBB Mechanical Services and Minas Basin Pulp & Power - copies attached.

Orders have been placed by Minas for motors for the boiler feed water pumps, the FD fan and the CWF off-loading pump.

A decision has been made by Minas personnel to purchase two - 35 cubic foot water softeners. The requirement for the new boiler is 22 cubic foot. The additional capacity will be used to provide quality water to the existing boilers. The two water softeners are valued at $43,000, the budgeted amount is $15,000. The decision was also made to upgrade the main water line to the boiler house from a 4" line to a six" line.

The boiler feed water tank, along with the two water softeners and all existing feed pumps will be located in a new building currently under construction. The cost of this additional work will be born to Minas Basin Pulp & Power.

Budget Variance Analysis

Cost Overruns - To Date

Civil Site Preparation As of 1987-11-30

1.	Base for ID fan	$ 3,520	
2.	Stack base elevated	1,488	
3.	Floor drains and oil separator	2,517	
4.	Jacques Whitford Soils Engineer	3,000	(est.)
5.	CKF effluent line relocation	13,950	
6.	Drain line from blowdown sump	3,000	(est.)
7.	Relocate fire water line	7,130	
8.	Piles for stack, ID fan and boiler	23,800	
9.	Extra 358 ft. of piles x $40/ft.	14,320	(est.)
	Sub Total	$ 72,725	

Boiler

10.	Pre-removal of boiler	4,666	
11.	CN flat bed demurrage	700	
12.	Blowdown tank	5,000	
	Sub Total	$ 10,366	
	Grand Total	$ 83,091	

A favorable variance of $4,910 has been realized in the purchase of the two heavy fuel oil atomizers. The revised budget figure was $12,000 and the actual cost was $7,090.

Please note that the cost of the two water softeners purchased by Minas Basin Pulp & Power does not show up in this month's budget report. Since the additional softener capacity and new building were not included in the original scope of work, a decision will have to made by the Steering Committee as to their inclusion.

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
11	FOUNDATION/STACK & FANS	30000	15620	60248	-44628	15620	45000
12	BOILER HOUSE / FOUNDATION	55000	90568	117665	-27097	89568	45000
13	CONTROL ROOM A/C	5000	8000	8000	0	0	0
14	PAINTING MAT/LAB	2500	7000	7000	0	0	0
10	CIVIL SITE PREPARATION	92500	121188	192913	-71725	105188	90000
21	BOILER PURCHASE	60000	60000	65000	-5000	65000	60000
22	STACK REMOVAL	2000	6025	6025	0	6025	0
23	STACK TRANSPORT	1000	880	880	0	880	0
24	STACK INSTALLATION	6000	8200	8200	0	8200	0
25	BOILER REMOVAL	12000	33791	38457	-4666	38475	0
26	BOILER TRANSPORT	7000	6680	6680	0	6680	0
27	BOILER INSTALLATION	44000	52208	52890	-682	52890	0
28	MECHANICAL MATERIALS	10000	50131	50130.1	0.9	50130.15	27359.12
29	MECHANICAL INSTALLATION	46000	34226	34226	0	34226	0
30	CONDENSATE RETURN SYSTEM	0	11100	11100	0	0	0
31	BOILER FEED SOFTENER	0	15000	15000	0	0	0
32	P & I ENGINEERING	0	1128	1128	0	1128	0
33	VIEW PORT ENLARGEMENT	0	500	500	0	500	0
20	BOILER	188000	279869	290216.1	-10347.1	264134.15	87359.12

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
41	CWF STORAGE TANK	30000	20000	9000	11000	9000	0
42	CWF PIPING MATERIALS	10000	3130	3130	0	3130	0
43	CWF PIPING INSTALLATION	13000	7930	7930	0	7930	0
44	CWF OFF-LOADING PUMP	10000	5000	5000	0	0	0
45	CWF TRANSFER PUMP	15000	15000	14425	575	14425	14425
46	HFO SET	0	20000	3500	16500	3500	0
47	HFO PIPING MATERIALS/INST.	0	10000	10000	0	0	0
40	FUEL HANDLING SYSTEM	78000	81060	52985	28075	37985	14425
51	CWF ATOMIZER (NRC)	18000	12000	12000	0	12000	0
52	HFO ATOMIZER	0	12000	7090	4910	7090	0
53	CWF BURNER FABRICATION	24000	13955	13955	0	13955	0
54	BURNER INST. STRUCTURAL MODS.	22000	13264	13264	0	13264	0
55	BURNER INST. REFRACTORY MODS.	30000	19151	19151	0	19151	0
56	BURNER INSTALLATION	2000	1080	1080	0	1080	0
57	CWF IGNITOR	7000	2750	2750	0	2750	0
58	BALANCE DRAFT DESIGN	3000	10080	10080	0	10080	0
59	BALANCE DRAFT DUCTWORK	10000	47000	47000	0	47000	0
60	BALANCE DRAFT INSTALLATION	7000	64917	64917	0	64917	0
61	AIR HEATER	40000	52452	52452	0	52452	0
62	ID FAN	0	37500	37500	0	37500	0
63	STEAM COIL AIR HEATER	0	12016	12016	0	12016	0
64	VIEW PORT	1200	900	900	0	900	0
50	CWF BURNER	164200	299065	294155	4910	294155	0

CAPE BRETON DEVELOPMENT CORPORATION

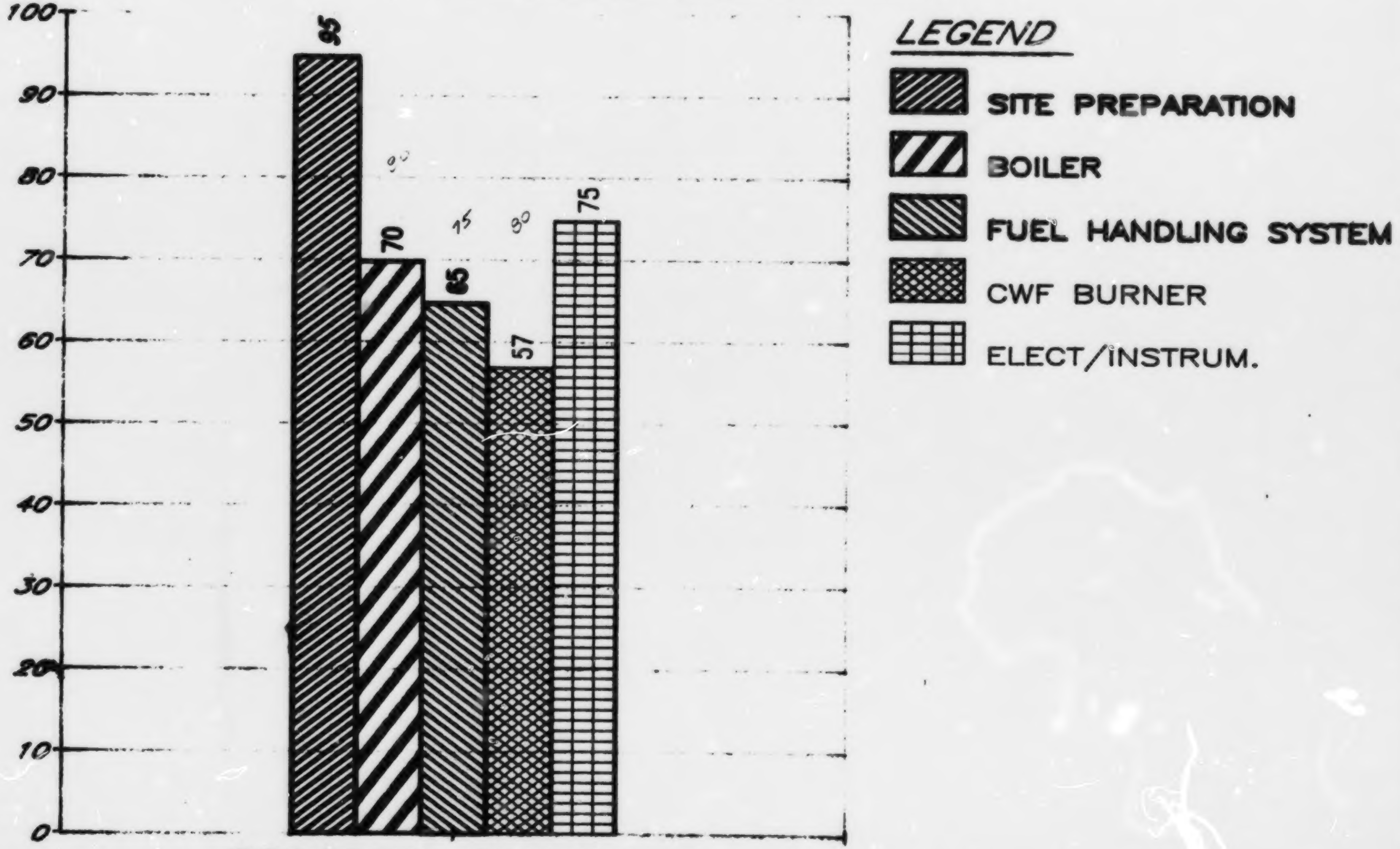
MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
71	COMPUTER/CONTROL SYSTEM	99000	109814	110341	-527	110341	19951
72	TRANSMITTERS FLOW ELEMENTS	30000	24626	24626	0	24559	14307
73	MAGNETIC FLOWMETER	6000	8228	8228	0	5736	0
74	CONTROL VALVES.POSITIONERS	18000	7955	7955	0	7955	0
75	AUTO VALVES.PI'S.TI'S.ETC.	20000	12000	12000	0	11043.29	0
76	ELECTRICAL CABLE TRAYS	5000	2000	2000	0	0	0
77	SUPPLY & INST. MAIN POWER	10000	14000	14000	0	7108	0
78	FLAME SCANNER	0	2947	2947	0	2947	0
79	CHEMICAL METERING PUMP	0	3174	3174	0	3174	3174
80	E & I INSTALLATION	0	12000	12000	0	0	0
70	ELECTRICAL INSTRUMENTATION	188000	196744	197271	-527	172863.29	37432
90	BONDING.PERMITS.CERTIFICATS	0	3134	3134	0	3134	0
100	PROJECT CONTINGENCY	65000	28000	0	28000	0	0
110	CAPITAL RECOVERY	0	0	0	0	N/A	0
TOTAL		779600	1009060	1030674.1	-21614.1	877459.44	229216.12

MBP&P CWF CONVERSION PROJECT
% COMPLETION



PROGRESS REPORT #3
NOV 30/87

[illegible]
DECEMBER 01, 1987

PROGRESS PAYMENT

MINAS BASIN PULP & POWER CO.LTD.
P.O. BOX. 401
HANSPORT, NOVA SCOTIA. B0P-1P0

PROJECT MINAS BASIN COAL WATER CONVERSION
CONTRACTOR M.B.B. MECHANICAL SERVICES LDT.
ADDRESS P.O.BOX.39, LAKE SIDE, N.S. B0J-1Z0
P.O. NO.

PAGE 1 OF 2
DATE
PROGRESS PMT. NO.
FROM TO

ITEM NO.	UNIT NO.	DESCRIPTION	CONTRACT AMOUNT				THIS CLAIM		PREVIOUS CLAIMS		TOTAL TO DATE	
			UNIT	UNIT PRICE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE
1	22	STACK REMOVAL			100%	6025						
2	23	STACK TRANSPORT			100%	880						
3	24	STACK INSTALLATION			100%	8200						
4	25	BOILER REMOVAL			100%	29125						
5	26	BOILER TRANSPORT			100%	6630						
6	27	BOILER INSTALLATION			100%	45708						
7	28	MECHANICAL MATERIALS			100%	20160						
8	29	MECHANICAL INSTALLATION			100%	34226						
9	32	P & I ENGINEERING			100%	1128						
10	33	VIEW PORT ENLARGEMENT/BACKWALL			100%	500						
11	42	CWF PIPING MATERIALS			100%	3130						
12	43	CWF PIPING INSTALLATION			100%	7930						

PREPARED BY:
CONTRACTOR . . . . . DATE
RECOMMENDED FOR PAYMENT . . . . .
PROJECT CONSTRUCTION MANAGER . . . . . DATE

EXTENSIONS CHECKED
PROJECT ADMINISTRATOR . . . . . DATE
APPROVED FOR PAYMENT . . . . .
PROJECT MANAGER . . . . . DATE

ORIGINAL CONTRACT VALUE 441891
APPROVED C.C.A'S
CURRENT CONTRACT VALUE
"AS OF" DATE
* NOT APPLICABLE TO FIXED PRICE CONTRACTS

WORK TO DATE VALUE
LESS HOLDBACK 10%
BALANCE
PREVIOUSLY CLAIMED
AMOUNT THIS CLAIM

PROGRESS PAYMENT

MINAS BASIN PULP & POWER CO.LTD.
P.O. BOX. 401
HANSPORT, NOVA SCOTIA. B0P-1P0

PROJECT MINAS BASIN COAL WATER CONVERSION
CONTRACTOR M.B.B. MECHANICAL SERVICES LDT.
ADDRESS P.O.BOX.39, LAKE SIDE. N.S. B0J-1Z0
P.O. NO.

PAGE 2 OF 2
DATE
PROGRESS PMT. NO.
FROM ______ TO ______

ITEM NO.	UNIT NO.	DESCRIPTION	CONTRACT AMOUNT				THIS CLAIM		PREVIOUS CLAIMS		TOTAL TO DATE	
			UNIT	UNIT PRICE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE
13	53	CWF BURNER FABRICATION/DELIVERY			100%	13955						
14	54	BURNER INST. STRUCTURAL MODS.			100%	13264						
15	55	BURNER INST. REFRACTORY MODS.			100%	19151						
16	56	BURNER INSTALLATION			100%	1080						
17	57	CWF IGNITOR			100%	2750						
18	58	BALANCE DRAFT DESIGN			100%	10080						
19	59	BALANCE DRAFT DUCTWORK			100%	47000						
20	60	BALANCE DRAFT INSTALLATION/DELIVERY			100%	64917						
21	61	AIR HEATER			100%	52452						
22	62	ID. FAN			100%	37800						
23	63	STEAM. COIL AIR HEATER			100%	12016						
24	64	VIEW PORT/BURNER END			100%	900						
25	90	BONDING,PERMITS,CERTIFICATES			100%	3134						

PREPARED BY:
CONTRACTOR . . . . DATE
RECOMMENDED FOR PAYMENT
PROJECT CONSTRUCTION MANAGER . . . . DATE

EXTENSIONS CHECKED
PROJECT ADMINISTRATOR . . . . DATE
APPROVED FOR PAYMENT
PROJECT MANAGER . . . . DATE

ORIGINAL CONTRACT VALUE 441891
APPROVED C.C.A'S
CURRENT CONTRACT VALUE
"AS OF" DATE
• NOT APPLICABLE TO FIXED PRICE CONTRACTS

WORK TO DATE VALUE
LESS HOLDBACK 10%
BALANCE
PREVIOUSLY CLAIMED
AMOUNT THIS CLAIM

DESCRIPTION OF THE CANMET/NRC BURNER AND ATOMIZER FOR THE PACKAGE BOILER INSTALLATION AT THE MINAS BASIN PULP AND POWER COMPANY, HANSPORT, NOVA SCOTIA

1. BACKGROUND

The Canada Center for Mineral and Energy Technology (CANMET) burner register and the National Research Council (NRC) two-fluid fuel atomizer for coal-water fuel (CWF) and heavy fuel oil (HFO) combustion, was developed as part of the R & D initiatives on CWF technology undertaken by Energy Mines and Resources (EMR) Canada. Funding and technical expertise for this specific development was provided by the Canada Center for Mineral and Energy Technology (CANMET), a R & D division within EMR. The National Research Council (NRC) was subcontracted by CANMET to build the atomizer component of this burner system.

At the present time the burner may be classified as an operational prototype. The developmental work undertaken since 1984 has been based on flame scaling trials at 6 million Btu/h, 40 million Btu/h, and a 55 million Btu/h firing rates. The present prototype to be installed in the Minas Basin Pulp & Power Company's (MBP & P) coal-water fuel fired package boiler has been tested at a nominal 55 million Btu/h scale, with an upper limit of 70 million Btu/h and a lower limit of 33 million Btu/h, representing a 2:1 turn down ratio on CWF. A corresponding turn down ratio of 8:1 was also demonstrated on HFO. These trials were undertaken in Unit No. 10, an oil-designed utility boiler at the Maritime Electric Company's Charlottetown Generating Plant. Proving trials, and the commercialization of this prototype version rated at a nominal 55 million Btu/h for industrial and utility boiler applications, is dependent on the outcome of the present demonstration program in the MBP & P package steam boiler, and a 5 burner test program to be completed in summer 1988 at the Charlottetown generating plant. These applications, beside demonstrating burner performance, will also provide boiler performance, environmental emission data, and long term capital and operating costs assessments for the conversion from HFO to CWF.

2. TECHNICAL DESCRIPTION

A. BURNER REGISTER AND QUARL

The burner register comprises of two parts; a mechanical assembly of swirl vanes, flow separation ducts and control dampers, and a refractory quarl. The mechanical assembly, which is fabricated as an integral unit provides a means for optimizing air-fuel mixing to create a defined flame envelope in the boiler. The quarl which is cast from refractory in the boiler front wall, serves as an outlet for the combustion air flow from the register. The burner register and quarl design combination, play a critical role in acheiving the desired air flow and fuel spray mixing patterns necessary to sustain stable ignition and burnout of the fuel within the boiler chamber.

A schematic diagram of the CANMET burner register/quarl design, and the resulting flow mixing pattern is shown in figure 1. The burner register is configured to generate concentric primary and secondary swirling combustion air jets, with independent control of the swirl level and mass flow in the respective air streams. The latter feature provides a method to sustain stable coal-water fuel and oil flames, employing an identical register configuration with fuels which differ significantly in their chemical reactivity. This dual fuel firing capability is generally obtained by adjusting the relative swirl/mass flow rates between the primary and secondary streams, to reduce flow mixing and heat dilution in the recirculation zone when firing the less reactive CWF. With the introduction of the combustion air flow in staged primary and secondary streams in the burner, and due to the high moisture content in the the fuel which lowers the CWF flame temperature, NO_x generation in the flame is reduced by approximately 30% relative to conventional pulverized coal fired burners. A simultaneous reduction in the sulphur emission when burning CWF is also obtained because sulphur bearing pyrites are liberated and removed as part of the CWF production process.

B. FUEL ATOMIZER

Figure 2 shows a schematic illustration of the NRC dual fuel (CWF/HFO) two-fluid atomizer. The atomizer is a pre-filming nozzle with an outer liquid fuel sheet which is broken up by an inner concentric atomizing steam flow. The atomizer contains a conical ceramic tip and matching ring, and the angle of the cone and ring assembly determines the angle of the fuel spray. The spray angle is an adjustable parameter, and is often selected in field trials to generate the most compact and stable flames. Depending on the furnace configuration, the optimum spray angles may also differ for CWF and HFO combustion.

The atomizer discharge area is adjustable, and is controlled by an external micrometer with low and high gap settings on a graduated scale. This adjustable feature permits fine tuning of the nozzle to maintain throughput, high outlet discharge velocities, and a spray quality independent of the variable shear dependent rheology of CWFs. The same adjustable feature also permits a convenient means of fuel switching to HFO by closing down the discharge gap. This reduction is necessary due to large differences in the viscosity of HFO and CWF, which would otherwise cause a higher oil throughput to the burner during fuel switching. The ceramic cone and ring assembly in the atomizer is abrasion resistant, and prevents wear of critical nozzle components. This feature also maintains the spray quality, the deterioration of which will rapidly destabilize a CWF flame.

Dr. K.V. Thambimuthu,
Research Scientist,
Energy Research Laboratories,
CANMET,
Energy Mines and Resources,
Ottawa.

6th November 1987

c.c. Cape Breton Development
Corporation, Sydney, NS.

Nova Scotia Department of
Mines and Energy, Halifax, NS.

Minas Basin Pulp and Power
Co., Hansport, NS.

DESCRIPTION OF THE CANMET/NRC BURNER AND ATOMIZER FOR THE PACKAGE BOILER INSTALLATION AT THE MINAS BASIN PULP AND POWER COMPANY, HANSPORT, NOVA SCOTIA

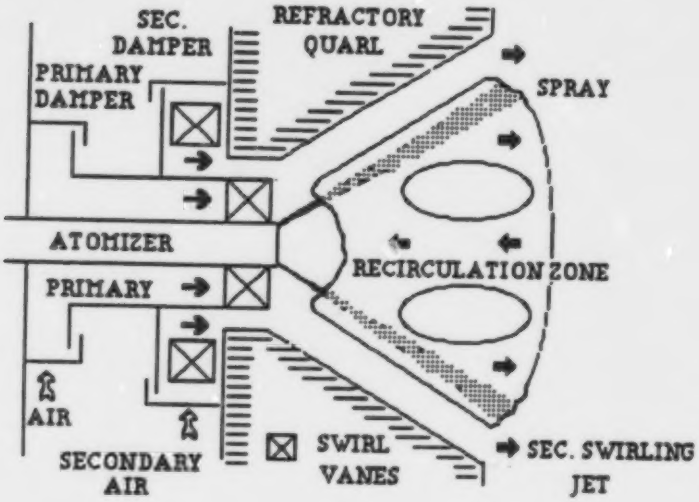

SEC. DAMPER
REFRACTORY QUARL
PRIMARY DAMPER
SPRAY
ATOMIZER
RECIRCULATION ZONE
PRIMARY
AIR
SECONDARY AIR
SWIRL VANES
SEC. SWIRLING JET

FIGURE 1. CANMET BURNER REGISTER, QUARL AND FLOW PATTERNS.

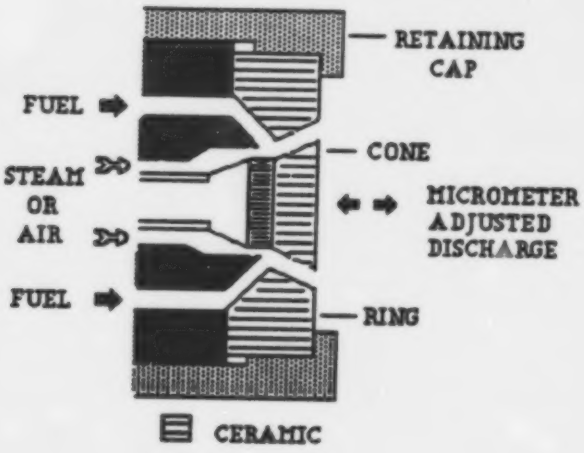

RETAINING CAP
FUEL
CONE
STEAM OR AIR
MICROMETER ADJUSTED DISCHARGE
FUEL
RING
▤ CERAMIC

FIGURE 2. SCHEMATIC DIAGRAM OF THE NRC DUAL FUEL ATOMIZER

71 E Fv6 PR3

PROCESS
JAN 14 1988
TECHNOLOGY

MINAS BASIN PULP & POWER

CWF CONVERSION

PROJECT REPORT #4

1987-12-31

DISTRIBUTION

MEMBERS OF STEERING COMMITTEE

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Kelly Thambimuthu, Canmet
Phil Read, Energy, Mines & Resources, Canada
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Lorne MacNeil, Canada-N.S. Oil Substitution Fund
Adrian White, Cape Breton Development Corporation

Prepared by:

Robert Kazmel
Joel MacLean

Significant Events

Both coal-water fuel tanks were placed in the sump on 1987-12-01. The stack erection was completed the following day along with the placement of the deaerator tank and platform.

The coal-water fuel tanks were both opened for inspection 1987-12-03. Both tanks appear to be in excellent condition with no signs of residual oil.

MBB Mechanical personnel began installation of the combustion air ducting on 1987-12-02 and RKO Fabricators were on site the following day to commence erection of the boilerhouse steel work.

Both coal-water fuel tanks were cleaned on 1987-12-07. They will both require a second cleaning to remove slag once construction is completed.

Word was received from MBB Mechanical Services that they would not be supplying a damper drive for the F.D. fan. A letter was then forwarded to MBB pointing out the sections of the tender package which clearly state that it is their responsibility to supply the damper. No written response was forthcoming from MBB by month's end.

The combustion air ducting along with the boiler flue gas outlet were completed from the boiler to the air heater on 1987-12-07. The hood for the air heater was also completed on 1987-12-07.

The boiler windbox extension arrived on 1987-12-08 along with the boiler feed water tank. Word was also received from MBB Mechanical Services that Fenco had been sub-contracted for the engineering of the steam header extension. The cost of the engineering will be approximately $11,000. MBB Mechanical Services estimated the installation price to be $40,000. A contract change authorization was issued for the engineering but not for the installation. A decision on the installation will be made once the drawings and the material listings have been received. A representative of Fenco was on site that afternoon of 1987-12-09.

Installation of the deaerator relief valve along with both boiler relief and the main steam stop check valves commenced on 1987-12-10.

The forced draft fan along with both boiler feed water pumps arrived on site the afternoon of 1987-12-11.

Minas Basin personnel completed work on the motor control room modification on 1987-12-14. MBB Mechanical Services started the windbox modifications. Copies of invoices from both MBB Mechanical Services and Lindsay were received on this date. The invoices were for $207,075.60 and $128,598.50 respectively. An invoice for $87,090 was also received from Bailey Control for the Bailey Network 90 Control System.

Word was received from MBB Mechanical Services that all construction activities will cease on 1987-12-18 and will not resume until 1988-01-04. A letter was telecopied off to MBB Mechanical Services requesting written verification along with obtaining the reason for such a decision and detailing the effect such a decision will have on the planned completion date.

A meeting was held at the MBB Mechanical Services office to:

1. review their reason for stopping construction activities;

2. to view the Canmet air register drawings;

3. to view the work to date on the piping drawings.

Two of the fifteen (15) Canmet drawings along with a single piping drawing were produced. The meeting adjourned with the understanding that MBB would forward a written response to my letter of 1987-12-14 and that all piping drawings would be ready for review meeting scheduled for 1988-01-05. No written response had been received from MBB by month's end.

MBB Mechanical Services personnel started the removal of the oil set from Dalhousie University on 1987-12-15.

All purchaser supplied material were forwarded to the Minas site on 1987-12-16. The soot blower was removed from the boiler on 1987-12-17. It was then forwarded to Mobil Valves for a rebuild. The F.D. fan was also placed on its base on this date.

Work started on installing the building siding on 1987-12-18. All purchaser supplied equipment arrived on site on this date along with the induced draft fan.

All boiler construction activities ceased on this date. Lindsay were to continue working on the building siding weather permitting. At month's end, the building siding and roofing were approximately 50% complete.

Electrical and Instrumentation

During December, all materials purchased by CBDC for the Minas Basin project were shipped to MBP&P. These materials included the automatic valves, control valves, manual valves, water columns, pumps, agitators, flame scanners, safety switches, flowmeters, motor control equipment, etc. MBP&P also took delivery of the process control unit and the operator interface unit from Bailey Controls Company.

Equipment manuals were prepared by CBDC and forwarded to MBP&P, along with wiring diagrams for the process control units and the various pieces of equipment. There are two (2) wiring drawings not completed and these will be forwarded to MBP&P when complete. There are four (4) instruction booklets which are not yet available and these will be forwarded to MBB when received.

A draft of the boiler start-up and operating procedures has been prepared by CBDC and forwarded to MBP&P for their perusal and comments. The final procedures will be prepared in January.

CBDC are still awaiting delivery of one (1) 2" gate valve and one (1) oil temperature switch. In addition, there may be other valving and material requirements necessary. These additional requirements will be known after MBB Mechanical finalize the pipe and valving layouts.

There are some minor modifications to be made to the control system software, and these will be carried out in early January. Operator training and familiarization on the system will commence in early January. The new project schedule start-up date for oil is 1988-02-15.

BUDGET VARIENCE ANALYSIS

COST OVERRUNS TO DATE

CIVIL SITE PREPARATION

BASE FOR ID FAN		3520
STACK BASE ELEVATED		1488
FLOOR DRAINS & OIL SEPARATOR		2517
JACQUES WHITFORD SOILS ENGINEER		5311.53
CKF EFFLUENT LINE RELOCATION		13950
DRAIN LINE FROM BLOWDOWN SUMP	(EST)	3000
RELOCATE FIRE WATER LINE		7130
PILES FOR STACK.ID FAN & BOILER		35259
EXTRA 358FT 4IN OF PILES @ $40/FT		14320
SUMP BELOW DEAERATOR	(EST)	1500
FINAL ADJ. OF STRUCTURAL FILL	(EST)	1000
DESIGN CHANGE FOR STACK BASE		3221
	SUB TOTAL	92216.53

BOILER

PRE-REMOVAL OF BOILER		4666
CN FLAT BED DEMURRAGE	(EST)	700
BLOWDOWN TANK		12750
TEFC MOTOR FOR ID FAN	(EST)	6000
HEADER STEAM HEATER ENGINEERING		1100
STEAM HEADER INSTALLATION		22000
	SUB TOTAL	~~25216~~ 47,216
	GRAND TOTAL	~~117432.53~~ 139,432.53

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
11	FOUNDATION/STACK & FANS	30000	15620	95507	-79887	15620	74928
12	BOILER HOUSE / FOUNDATION	55000	90568	117665	-27097	89568	68350.5
13	CONTROL ROOM A/C	5000	9000	9000	0	0	0
14	PAINTING MAT/LAB	2500	7000	7000	0	0	0
10	CIVIL SITE PREPARATION	92500	121188	229172	-106984 922/6.5	105188	143278.5
21	BOILER PURCHASE	60000	60000	72750	-12750 ✓	65000	60000
22	STACK REMOVAL	2000	6025	6025	0	6025	6025
23	STACK TRANSPORT	1000	880	880	0	880	880
24	STACK INSTALLATION	6000	9200	9200	0	9200	9200
25	BOILER REMOVAL	12000	33791	38457	-4666 ✓	38475	33791
26	BOILER TRANSPORT	7000	6680	6680	0	6680	6680
27	BOILER INSTALLATION	44000	52208	52890	-682	52890	45702
28	MECHANICAL MATERIALS	10000	50131	50130	1	50130.15	47519.12
29	MECHANICAL INSTALLATION	46000	34226	34226	0	34226	32519.75
30	CONDENSATE RETURN SYSTEM	0	11100	11100	0	0	0
31	BOILER FEED SOFTENER	0	15000	15000	0	0	0
32	P & I ENGINEERING	0	1129	1129	0	1129	1068.75
33	VIEW PORT ENLARGEMENT	0	500	500	0	500	0
20	BOILER	188000	280869	298966	-18097	264134.15	242391.62

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
41	CWF STORAGE TANK	30000	20000	9000	11000	9000	0
42	CWF PIPING MATERIALS	10000	3130	3130	0	3130	3130
43	CWF PIPING INSTALLATION	13000	7930	7930	0	7930	7930
44	CWF OFF LOADING PUMP	10000	5000	5000	0	0	0
45	CWF TRANSFER PUMP	15000	15000	14425	575	14425	14425
46	MFO SET	0	20000	3500	16500	3500	0
47	MFO PIPING MATERIALS/INST.	0	10000	10000	0	0	0
40	FUEL HANDLING SYSTEM	78000	81060	52985	28075	37985	25485
51	CWF ATOMIZER (NRC)	19000	12000	12000	0	12000	0
52	MFO ATOMIZER	0	12000	7090	4910	7090	0
53	CWF BURNER FABRICATION	24000	13955	13955	0	13955	10466.25
54	BURNER INST. STRUCTURAL MODS.	22000	13264	13264	0	13264	13131.36
55	BURNER INST. REFRACTORY MODS.	10000	19151	19151	0	19151	0
56	BURNER INSTALLATION	2000	1080	1080	0	1080	0
57	CWF IGNITOR	7000	2750	2750	0	2750	2750
58	BALANCE DRAFT DESIGN	3000	10080	10080	0	10080	10080
59	BALANCE DRAFT DUCTWORK	10000	47000	47000	0	47000	47000
60	BALANCE DRAFT INSTALLATION	7000	64917	64917	0	64917	58425.3
61	AIR HEATER	10000	52452	52452	0	52452	52452
62	ID FAN	0	37500	43500	-6000 ✓	37500	33750
63	STEAM COIL AIR HEATER	0	12016	12016	0	12016	12016
64	VIEW PORT	1200	900	900	0	900	0
50	CWF BURNER	144200	299065	300155	-1090	294155	240070.91

CAPE BRETON DEVELOPMENT CORPORATION

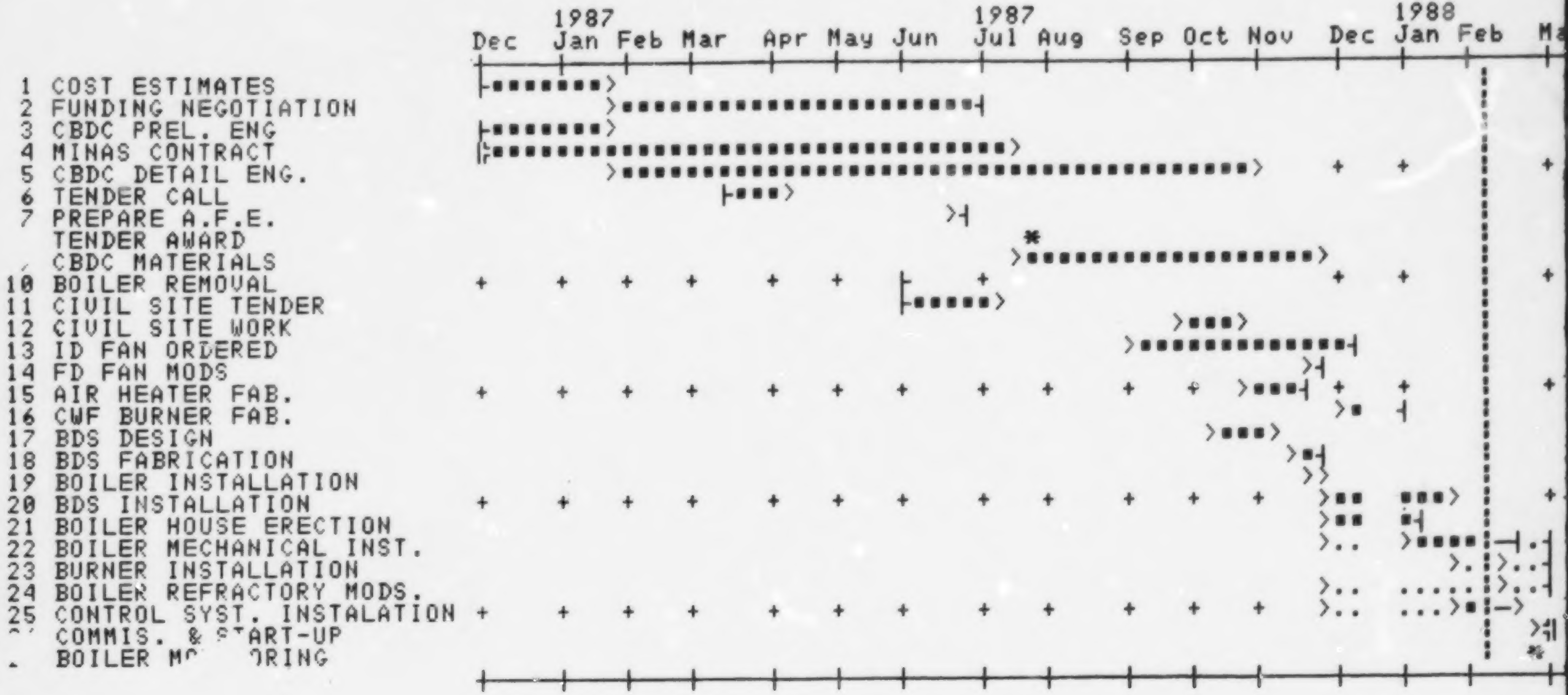
MINAS BASIN PULP AND POWER

CWF CONVERSION

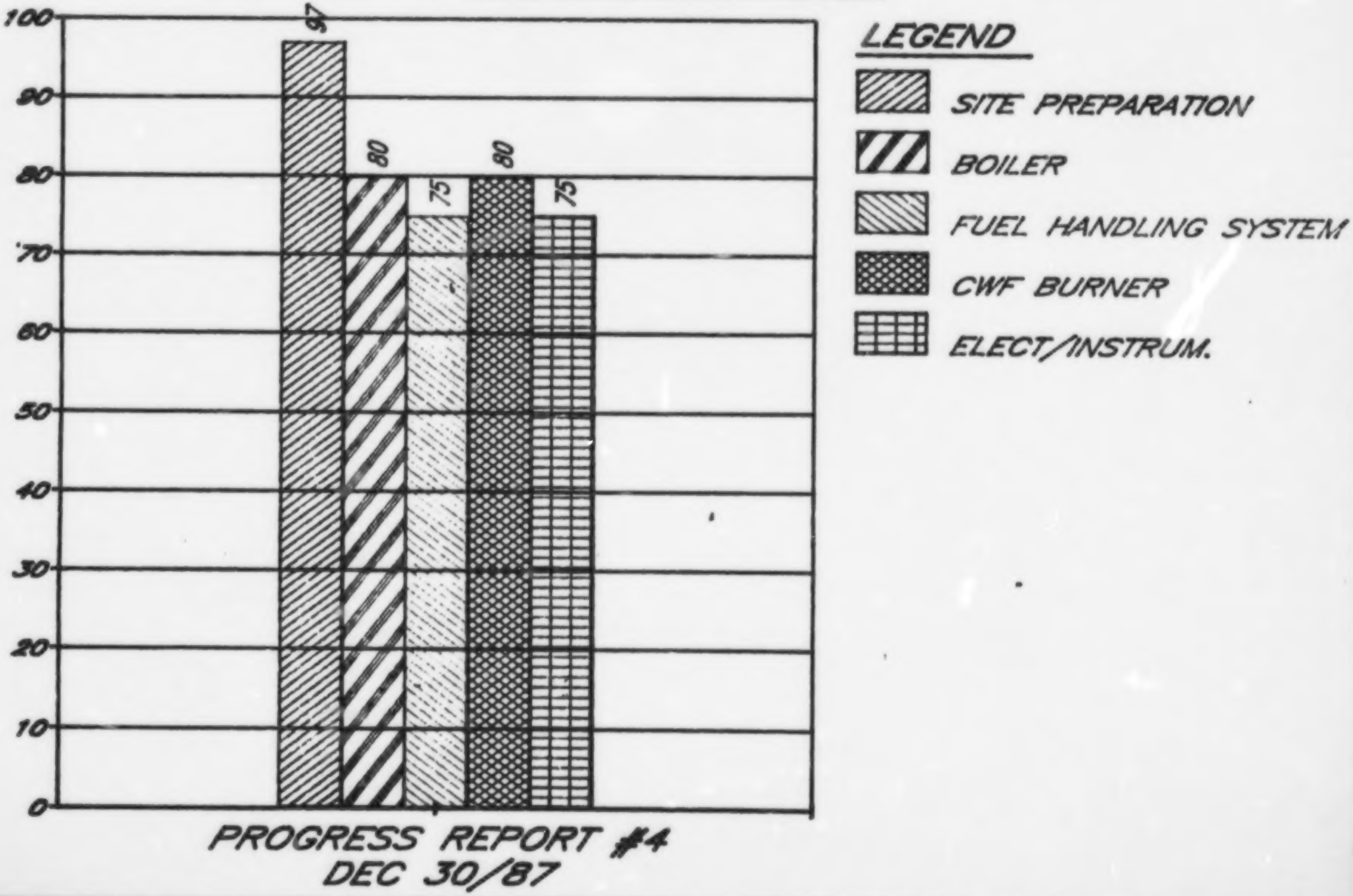
1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
71	COMPUTER/CONTROL SYSTEM	99000	107814	110341	-527	110341	108881
72	TRANSMITTERS FLOW ELEMENTS	30000	24625	24626	0	24559	14307
73	MAGNETIC FLOWMETER	6000	9229	9229	0	5736	0
74	CONTROL VALVES.POSITIONERS	18000	7955	7955	0	7955	0
75	AUTO VALVES.PI'S.TI'S.ETC.	20000	12000	12000	0	11063.29	0
76	ELECTRICAL CABLE TRAYS	5000	2000	2000	0	0	0
77	SUPPLY & INST. MAIN POWER	10000	14000	14000	0	7108	0
78	FLAME SCANNER	0	2967	2967	0	2967	0
79	CHEMICAL METERING PUMP	0	3174	3174	0	3174	3174
80	E & I INSTALLATION	0	12000	12000	0	0	0
70	ELECTRICAL INSTRUMENTATION	188000	195744	197271	-527	172863.29	126362
90	BONDING.PERMITS.CERTIFICATS	0	3134	3134	0	3134	0
100	PROJECT CONTINGENCY	65000	29000	0	29000	0	0
110	CAPITAL RECOVERY	0	0	0	0	N/A	0
TOTAL		779600	1009060	1079683	-70623	977459.44	777588.02

MINAS CWF CONVERSION PROJECT
JANUARY 31 1988



MBP&P CWF CONVERSION PROJECT
% COMPLETION



MINAS BASIN PULP & POWER

CWF CONVERSION

PROJECT REPORT #5

1988-01-30

DISTRIBUTION

MEMBERS OF STEERING COMMITTEE

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Kelly Thambimuthu, Canmet
Phil Read, Energy, Mines & Resources, Canada
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Lorne MacNeil, Canada-N.S. Oil Substitution Fund
Adrian White, Cape Breton Development Corporation

Prepared by:

Robert Kazmel
Joel MacLean

Significant Events

Construction activities resumed on 1988-01-04. MBB Mechanical Services assigned three additional personnel to the construction portion of the project, (two pipe fitters and a pipe fitter foreman).

Due to the extremely poor weather conditions Lindsay Enterprises were unable to complete graveling and flashing around the perimeter of the boilerhouse roof. However, the building was made weather tight by 1988-01-11.

A piping review meeting was conducted at the offices of MBB Mechanical Services on 1988-01-05, attendees included: Dave Lawrence, MBB; Gordon Brenton, MBP&P; Kelly Thambimuthu, Canmet; Joel MacLean, CBDC and R. Kazmel, CBDC.

Copies of 1) package boiler location loading diagram; 2) package boiler location section; 3) feedwater supply and deaerator; 4) CWF burner piping; 5) CWF supply piping are attached.

A Project Steering Committee meeting was conducted on 1988-01-06. For details see Minutes of Meeting.

A meeting was held with Minas Pulp & Power instrumentation personnel on 1988-01-07, the purpose of which was to familiarize them with the instrumentation requirements of the project.

Minas Basin personnel commenced construction of the water treatment building and installation of the cable trays on 1988-01-08.

Minas Basin personnel completed overhauling of the two boiler feed water pumps on 1988-01-11. Both pumps were installed by MBB Mechanical Services personnel on 1988-01-12.

The oil set installation was completed by MBB Mechanical Services on 1988-01-13. Minas Basin Pulp & Power had contracted MBB Mechanical Services under a separate purchase order for this installation. The terms of the arrangement were cost plus. As of month's end, no price had been received by Minas.

The Bailey operator interface unit was powered up and tested on 1988-01-13. A meeting was held with Peter Zwicker the purpose of which was to review the boiler start-up procedures and piping drawings.

The ID fan shaft, pedestals and blower were removed from site on 1988-01-14. Due the extreme weather conditions, the bearings were set in the shop and the assembly was re-delivered the following day.

The Fenco drawing for the steam header extension were delivered to MBB Mechanical Services on 1988-01-15. On 1988-01-21 a quotation was received from MBB Mechanical Services for the installation of the steam header, ($56,980.00). MBB Mechanical Services were contacted and informed that the price was totally unrealistic. Upon reviewing the quotation, it was determined that a good portion of the quotation was already included in the original tender package. MBB were asked to re-submit a price for the agreed upon work. At month's end no price had been received.

A Technical Steering Committee meeting was held on 1988-01-15, the purpose of which was to review the piping drawings, the boiler start-up procedures and the operation of the operator interface unit.

Attendees included:

Kelly Thambimuthu	Canmet
Adam Bennett	NRC
David Lawrence	MBB
Peter Zwicker	MBP&P
Gordon Brenton	MBP&P
Joel MacLean	CBDC
Robert Kazmel	CBDC

Minutes of the meeting are attached.

Due to the requirement of Labour Canada that all pressure vessel fabricators have an American Society of Mechanical Engineers U stamp, the purchase order for the fabrication of the boiler blowdown tank, which had previously been placed with Sydney Engineering, had to be cancelled. A purchase order was then placed with Woodside Fabricators Limited, the purchase price was $12,750 and the expected delivery date is 1988-02-21.

The balanced draft system installation was completed on 1988-01-29 and the boiler feed water supply and deaerator piping was approximately 80% complete.

The new completion date for the project is now 1988-02-26 with commissioning to commence on 1988-02-29. The boiler will be hydrostatically tested the week of 1988-02-22. To date, the project is some six weeks behind the original forecasted schedule.

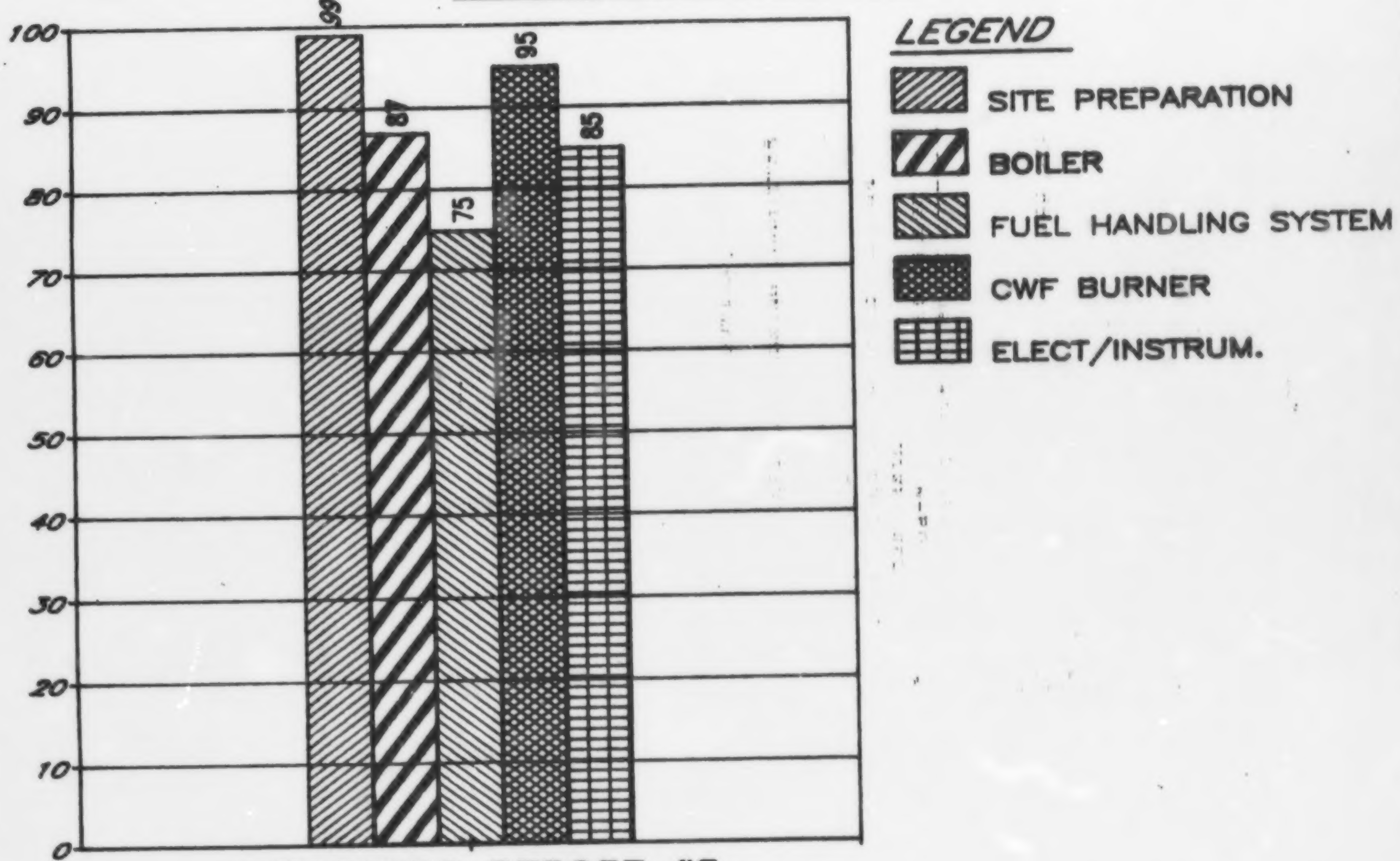
Instrumentation/Controls

Installation of elements that are integral to the piping has commenced. This includes the majority of the flow elements, transmitters, control valves and auto two position valves. The instrument group at the Minas site are checking the calibration of these elements prior to installation. They are also ensuring that recommended installation procedures are being followed during installation. Installation of the control units, the operator interface console, the computer and the motor control center will commence upon the completion of the control room and the electrical room. Following this, actual physical wiring will commence.

Appropriate Minas personnel have been provided with a complete listing of the module configurations, along with logic drawings of the control and burner management. The configurations have been supplied on paper and on diskette. The control room computer has been delivered to the Minas site and has been verified as functional. Informal training will commence on the system in early February.

The operator interface unit has been temporarily installed at the Minas site and a brief introduction given to Minas personnel, although thorough training will be required prior to start-up. Canmet and N.R.C. also had a brief introduction to the system.

MBP&P CWF CONVERSION PROJECT
% COMPLETION



PROGRESS REPORT #5
JAN 30/88

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
11	FOUNDATION/STACK & FANS	30000	15620	60248	-44628	15620	60248
12	BOILER HOUSE / FOUNDATION	55000	90568	117665	-27097	89568	68350.5
13	CONTROL ROOM A/C	5000	8000	8000	0	0	0
14	PAINTING MAT/LAB	2500	7000	7000	0	0	0
10	CIVIL SITE PREPARATION	92500	121188	192913	-71725	105188	128598.5
21	BOILER PURCHASE	60000	60000	65000	-5000	65000	60000
22	STACK REMOVAL	2000	6025	6025	0	6025	6025
23	STACK TRANSPORT	1000	880	880	0	880	880
24	STACK INSTALLATION	6000	8200	8200	0	8200	8200
25	BOILER REMOVAL	12000	33791	38457	-4666	38475	33791
26	BOILER TRANSPORT	7000	6680	6680	0	6680	6680
27	BOILER INSTALLATION	44000	52208	52890	-682	52890	36566.4
28	MECHANICAL MATERIALS	10000	50131	50130.1	0.9	50130.15	41471.12
29	MECHANICAL INSTALLATION	44000	34226	34226	0	34226	0
30	CONDENSATE RETURN SYSTEM	0	11100	11100	0	0	0
31	BOILER FEED SOFTENER	0	15000	15000	0	0	0
32	P & I ENGINEERING	0	1128	1128	0	1128	0
33	VIEW PORT ENLARGEMENT	0	500	500	0	500	0
20	BOILER	188000	279869	290216.1	-10347.1	264134.15	193613.52

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
41	CWF STORAGE TANK	30000	20000	9000	11000	9000	0
42	CWF PIPING MATERIALS	10000	3130	3130	0	3130	0
43	CWF PIPING INSTALLATION	13000	7930	7930	0	7930	0
44	CWF OFF-LOADING PUMP	10000	5000	5000	0	0	0
45	CWF TRANSFER PUMP	15000	15000	14425	575	14425	14425
46	HFO SET	0	20000	3500	16500	3500	0
47	HFO PIPING MATERIALS/INST.	0	10000	10000	0	0	0
40	FUEL HANDLING SYSTEM	78000	81060	52985	28075	37985	14425
51	CWF ATOMIZER (BBC)	18000	12000	12000	0	12000	0
52	HFO ATOMIZER	0	12000	7090	4910	7090	0
53	CWF BURNER FABRICATION	24000	13955	13955	0	13955	0
54	BURNER INST. STRUCTURAL MODS.	22000	13264	13264	0	13264	0
55	BURNER INST. REFRACTORY MODS.	30000	19151	19151	0	19151	0
56	BURNER INSTALLATION	2000	1080	1080	0	1080	0
57	CWF IGNITOR	7000	2750	2750	0	2750	0
58	BALANCE DRAFT DESIGN	3000	10080	10080	0	10080	10080
59	BALANCE DRAFT DUCTWORK	10000	67000	67000	0	67000	37600
60	BALANCE DRAFT INSTALLATION	7000	64917	64917	0	64917	0
61	AIR HEATER	40000	52652	52652	0	52652	52652
62	ID FAN	0	37500	37500	0	37500	0
63	STEAM COIL AIR HEATER	0	12016	12016	0	12016	8411.2
64	VIEW PORT	1200	900	900	0	900	0
50	CWF BURNER	164200	299065	294155	4910	294155	108543.2

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
71	COMPUTER/CONTROL SYSTEM	99000	109814	110341	-527	110341	108881
72	TRANSMITTERS FLOW ELEMENTS	30000	24626	24626	0	24559	14307
73	MAGNETIC FLOWMETER	6000	8228	8228	0	5736	0
74	CONTROL VALVES,POSITIONERS	18000	7955	7955	0	7955	0
75	AUTO VALVES,PI'S,TI'S,ETC.	20000	12000	12000	0	11043.29	0
76	ELECTRICAL CABLE TRAYS	5000	2000	2000	0	0	0
77	SUPPLY & INST. MAIN POWER	10000	14000	14000	0	7108	0
78	FLAME SCANNER	0	2947	2947	0	2947	0
79	CHEMICAL METERING PUMP	0	3174	3174	0	3174	3174
80	E & I INSTALLATION	0	12000	12000	0	0	0
70	ELECTRICAL INSTRUMENTATION	188000	196744	197271	-527	172863.29	126362
90	BONDING,PERMITS,CERTIFICATS	0	3134	3134	0	3134	0
100	PROJECT CONTINGENCY	68900	28000	0	28000	0	0
110	CAPITAL RECOVERY	0	0	0	0	N/A	0
TOTAL		779600	1009060	1030674.1	-21614.1	877459.44	571542.22

BUDGET VARIENCE ANALYSIS

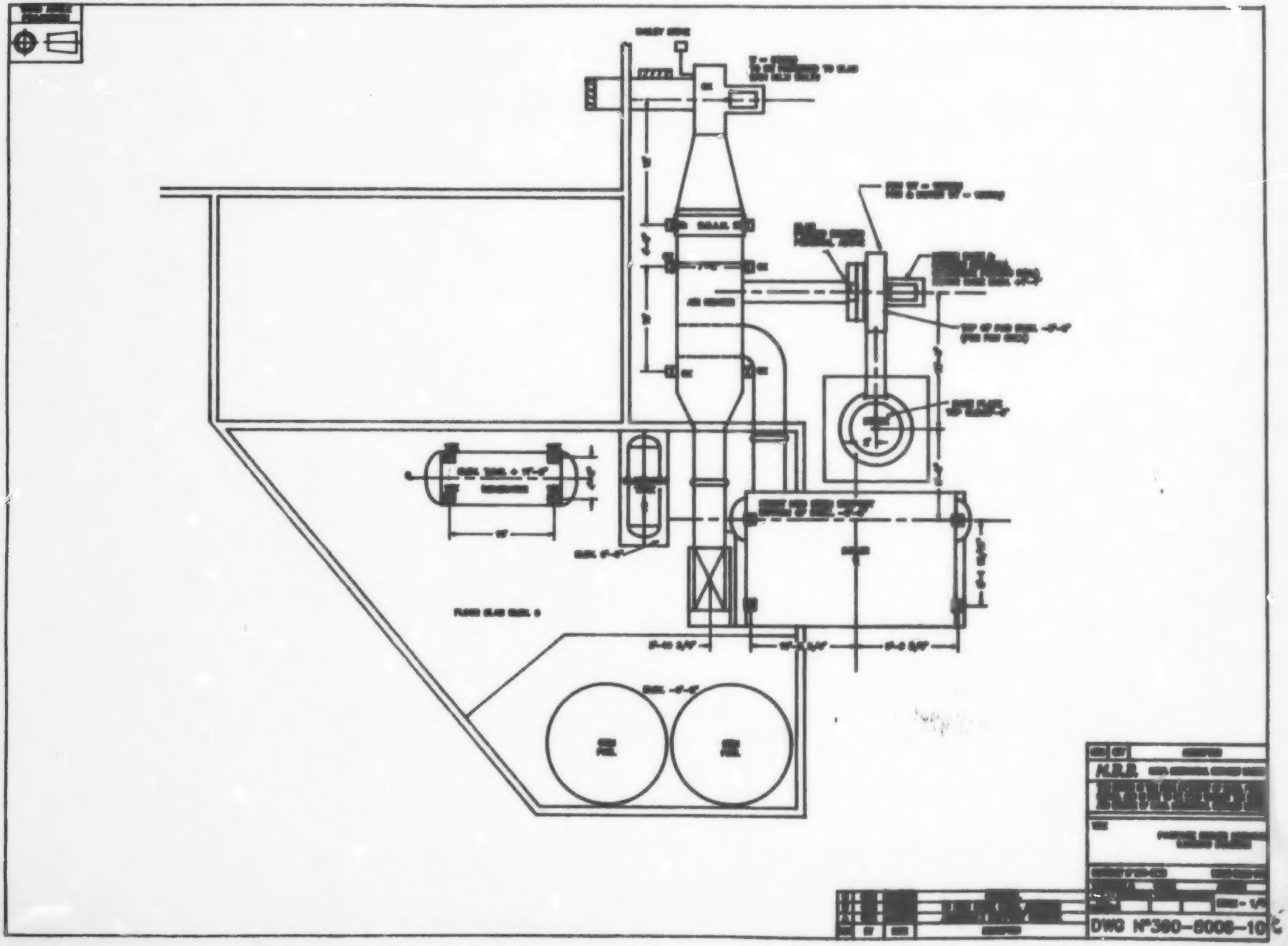
COST OVERRUNS TO DATE

CIVIL SITE PREPARATION

BASE FOR ID FAN		3520
STACK BASE ELEVATED		1688
FLOOR DRAINS & OIL SEPARATOR		2517
JACQUES WHITFORD SOILS ENGINEER		5311.53
CKF EFFLUENT LINE RELOCATION		13950
DRAIN LINE FROM BLOWDOWN SUMP	(EST)	3000
RELOCATE FIRE WATER LINE		7130
PILES FOR STACK,ID FAN & BOILER		23800
EXTRA 358FT 6IN OF PILES @ $40/FT		14320
SUMP BELOW DEAERATOR	(EST)	1500
FINAL ADJ. OF STRUCTURAL FILL	(EST)	1000
	SUB TOTAL	77536.53

BOILER

PRE-REMOVAL OF BOILER		4666
CN FLAT BED DEMURRAGE	(EST)	700
BLOWDOWN TANK		4500
	SUB TOTAL	9866
	GRAND TOTAL	87402.53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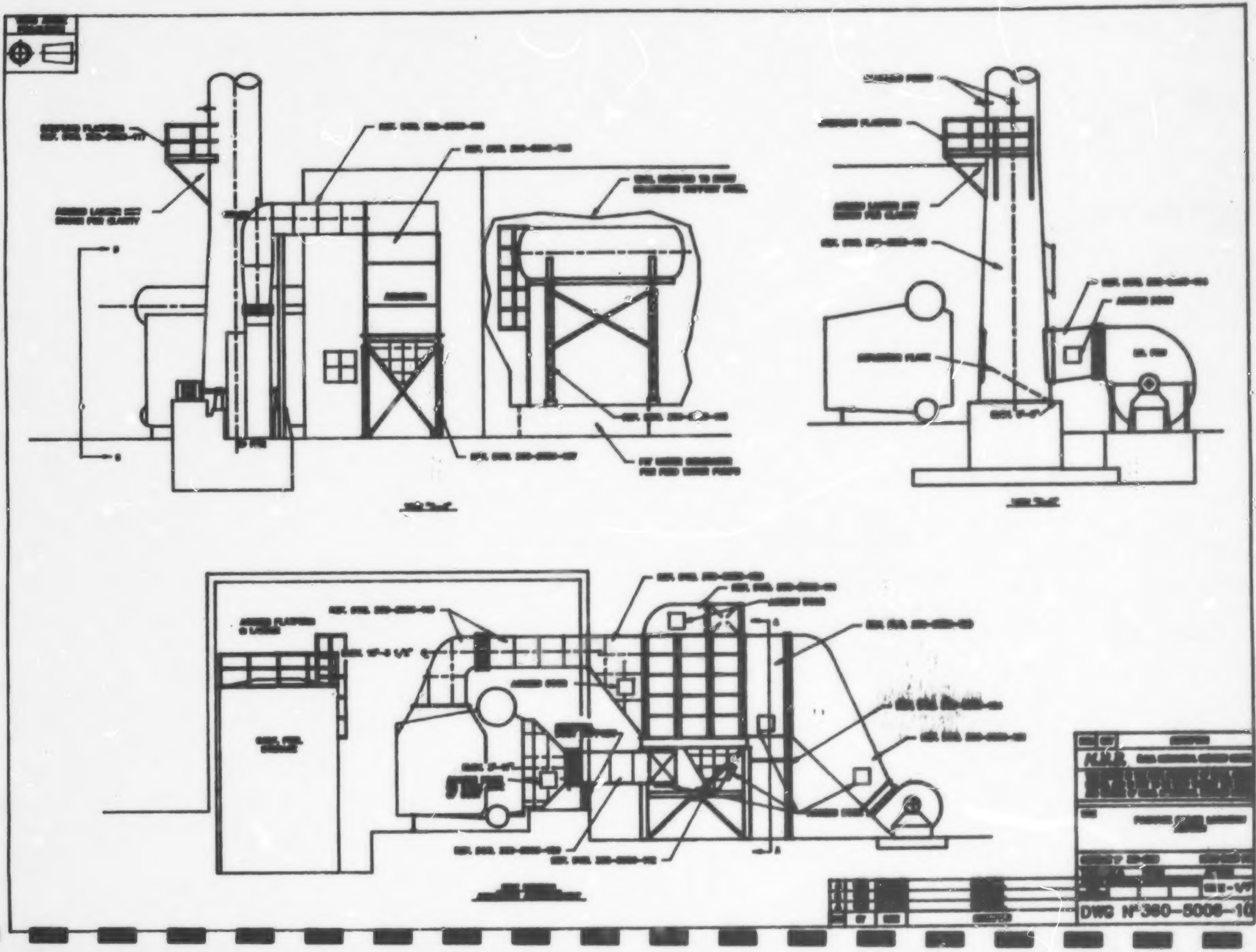
DWG N°380-8008-10



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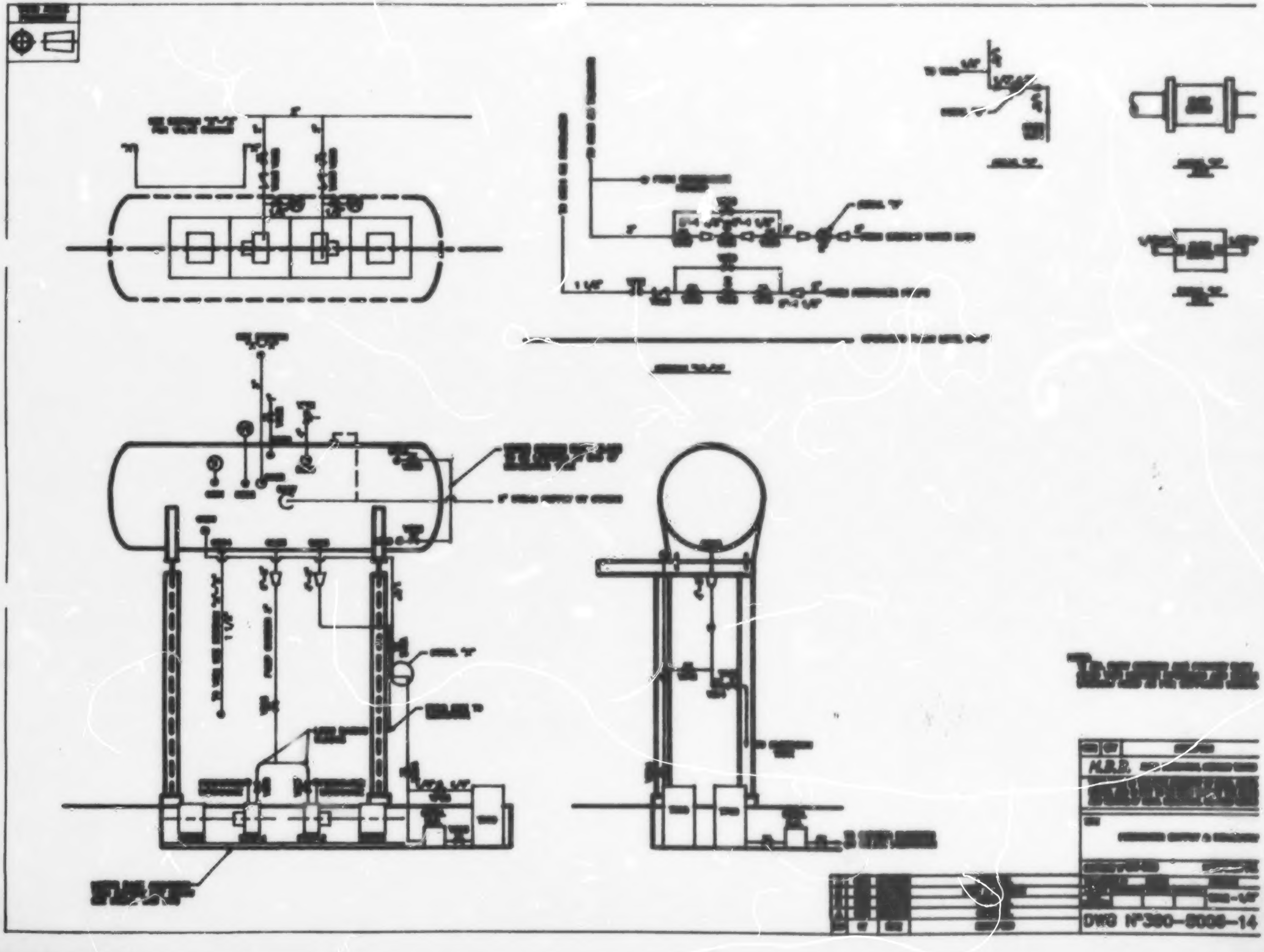
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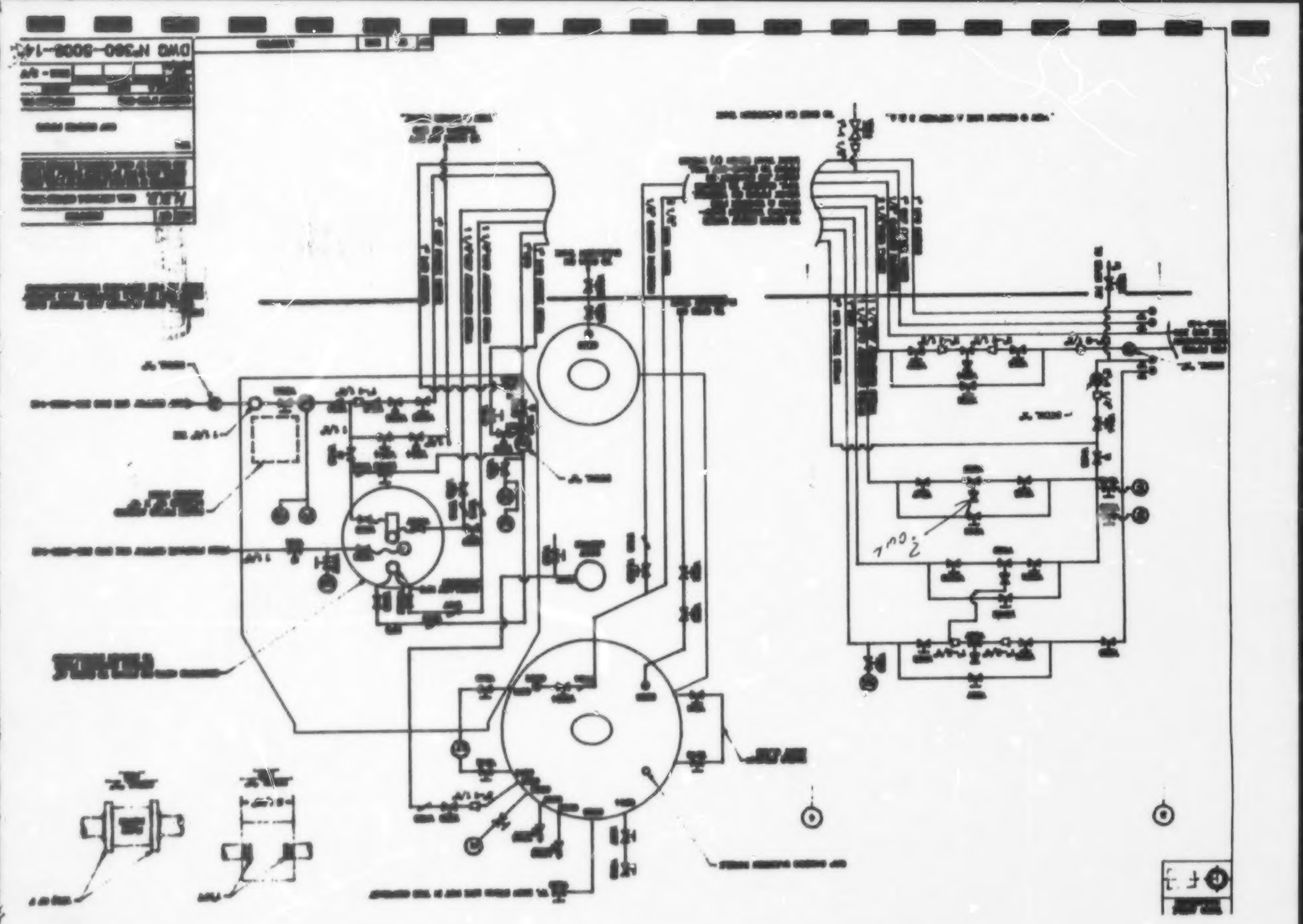
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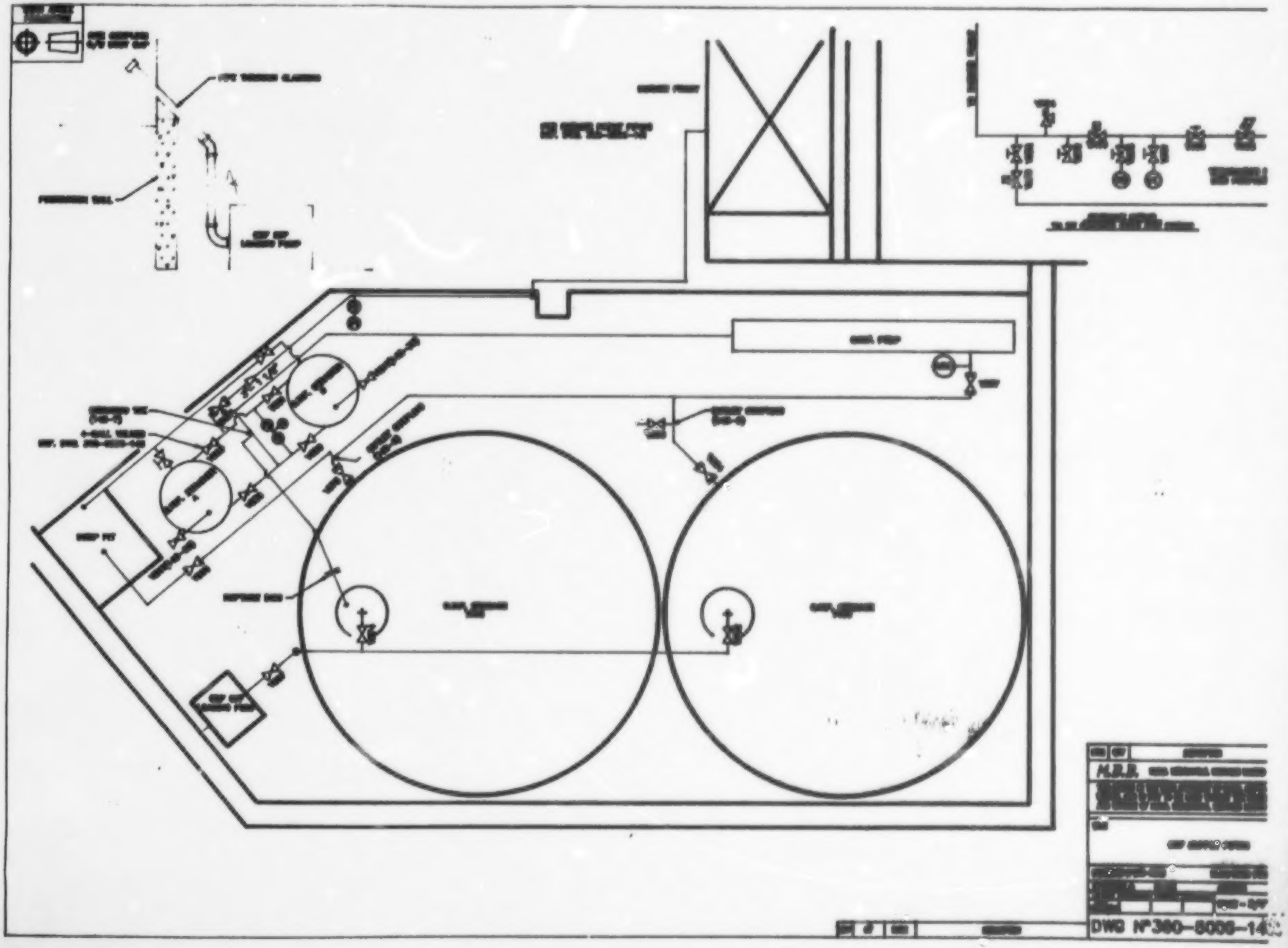
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1/2"
DWG Nº380-6000-14

MINAS BASIN PULP & POWER

CWF CONVERSION

PROJECT REPORT #6

1988-04-21

DISTRIBUTION

MEMBERS OF STEERING COMMITTEE

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Kelly Thambimuthu, Canmet
Phil Read, Energy, Mines & Resources, Canada
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Lorne MacNeil, Canada-N.S. Oil Substitution Fund
Adrian White, Cape Breton Development Corporation

Prepared by:

Robert Kazmel
Joel MacLean

Significant Events

Minas Basin personnel continued working on the water treatment building, installation of the metal roof and pouring of a new floor were completed by 1988-02-17. The new water softeners and sand filters arrived on site on 1988-02-10 and installation commenced on 1988-02-22, both units were commissioned on 1988-03-09.

A Technical Sub-committee meeting was held on 1988-02-09, minutes attached, the purpose of which was to review the air register drawings.

Canmet air register arrived on site along with the two CWF strainers on 1988-02-15. The air register was installed on 1988-02-16 along with the side viewport. The boiler refractory work was completed on 1988-02-22. Installation of both condensate return lines and water make-up lines to the deaerator were completed by Minas personnel on 1988-02-22. A Steering Committee meeting was held on 1988-02-25. For details see minutes of meeting. A meeting was also held with Dave Burnett, of MBB; the purpose of which was to discuss project related problems, minutes of meeting are attached.

Eric Mitchell, representing the Department of Labour, was on site on 1988-02-24 to witness the boiler pressure testing. The boiler was pressure tested to 300 psi. A copy of the inspection certificate is attached.

Eric Mitchell informed us that a ASME U stamp is not required for the boiler blowdown tank. It is up to the end user to determine what his standard should be. It is expected that the next revision of the Steam Boiler and Pressure Vessel Act will require an ASME U stamp for new installations.

The decision was made on 1988-02-12 not to give the steamheader extension to MBB Mechanical Services. MBB's price was $48,000, Gordon's Welding was $22,000.

MBB's complement on site was reduced from seven employees to five on 1988-02-24. The two terminated employees were both boilermakers.

The boiler blowdown tank arrived on site on 1988-03-01 and installation was completed by 1988-03-04. All MBB personnel were off site by 1988-03-04.

Gordon's Welding started work on steamheader extension on 1988-02-27, pressure testing of the main steamheader extension was witnessed by Eric Mitchell on 1988-03-06.

The decision was made to make repairs to the water tray in the deaerator tank on 1988-02-22. Gordon's Welding completed these repairs on 1988-03-04. T.J. Inspection Services completed magnetic partial inspection of all internal welds on 1988-03-06. Inspection report is attached. Eric Mitchell completed internal inspection of the boiler, the boiler steam drum, the boiler mud drum and the deaerator on 1988-03-04. Copies of the inspection certificates are attached.

Installation of five 40 gallon propane tanks by Speedy Propane personnel was completed on 1988-03-07. Insulation of the combustion air system as well as the motor from the ID fan were completed on this date.

The plant loop cable arrived on site on 1988-03-08 and the network 90 system was powered up. Work also commenced on the insulation of the process piping.

Both FD and ID fans were powered up and tested on 1988-03-04. No problems were encountered with the FD fan; however, the ID fan tripped after 11 seconds. The FD fan was up and running with the ID fan damper closed. The heater size was W38, this was changed to a W41 to allow for start-up of the fan.

Commissioning of the deaerator commenced on 1988-03-09 and was completed on 1988-03-11.

Commissioning of the balance draft system along with the boiler propane ignition system started on 1988-03-15 and was completed on 1988-03-25. The boiler ignitor was successfully started at 15:30 hrs. on 1988-03-25.

Commissioning of oil delivery system started on 1988-03-26 and resulted in the first heavy fuel oil flame being ignited at 18:19 hrs. on 1988-03-26. The boiler was tied into the main steam-header at 15:15 hrs. on 1988-03-30.

All piping drawings are presently being revised. To date only one drawing has been completed, see attached drawing - CWF Piping System.

Mechanical Deficiency List

Replace leaking valve on CWF strainer.

Reposition rupture disc closer to CWF strainers.

Relocate flush water line on CWF piping and install valve.

Install vent on CWF storage tank manuals.

Install diaphragm on CWF line.

Install a catch basin beneath the heavy fuel oil gun.

Controls, Electrical and Instrumentation

Installation of the process control unit, the operator interface unit, the computer and the motor control center is complete. All metering and control equipment has been installed and tested. All electrical and instrument wiring has been completed.

In general, the control system performed satisfactorily, although there were some software modifications required. In addition, during commissioning the following list of deficiencies have been noted and still require attention. These items, although important, will not prevent operation of the boiler and can be attended to while the boiler is running.

Oxygen analyzer requires calibration.

Temperature transmitters require calibration check.

Propane vent valve needs repair.

Atomizing steam transmitter piping requires completion.

Deaerator steam regulating valve requires adjustment.

Coal-water fuel atomizing steam regulator valve requires installation, along with the associated fuel/steam isolating diaphragm and control piping. Currently when running on coal-water fuel it is necessary to use by-pass steam line.

PCW software on the IBM computer requires updating to latest revision. The current version has a few bugs which affect the long-term logging capabilities of the system.

Combustion air low pressure switch has to be reset to two inches.

Because of high amperage draws on the induced draft fan during start-up and when running at ambient temperatures, strict adherence to operating procedure is required in order to avoid tripping the fan.

The differential pressure gauge across coal-water fuel strainers requires replacement.

Installation of an audible alarm on both the boiler trip and the O_2 analyzer.

Installation of a visible light to indicate when the ignitor is on.

Install a manual switch on the CWF PC pump.

The majority of these items are currently being attended to by CBDC and/or MBP&P personnel.

With the exception of the above noted items, the boiler controls operate satisfactorily when base loaded up to 50,000 pounds per hour of steam, on oil or coal-water fuel. The controls nave also been tested when the boiler is allowed to track steam demand and they performed well in this mode also.

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
11	FOUNDATION/STACK & FANS	30000	15620	97087.67	-81467.67	97087.67	97087.67
12	BOILER HOUSE / FOUNDATION	55000	90568	105759.19	-15191.19	105759.19	105759.19
13	CONTROL ROOM A/C	5000	8000	8000	0	0	0
14	PAINTING MAT/LAB	2500	7000	7000	0	0	0
10	CIVIL SITE PREPARATION	92500	121188	217846.86	-96658.86	202846.86	202846.86
21	BOILER PURCHASE	60000	60000	75526.08	-15526.08	75526.08	75526.08
22	STACK REMOVAL	2000	6025	6025	0	6025	6025
23	STACK TRANSPORT	1000	880	880	0	880	880
24	STACK INSTALLATION	6000	8200	8200	0	8200	8200
25	BOILER REMOVAL	12000	29125	36120.25	-6995.25	36120.25	36120.25
26	BOILER TRANSPORT	7000	6680	6680	0	6680	6680
27	BOILER INSTALLATION	44000	52208	46358	5850	46358	46358
28	MECHANICAL MATERIALS	10000	50131	59910.42	-9779.42	59910.42	59910.42
29	MECHANICAL INSTALLATION	46000	34226	54513.75	-20287.75	54513.75	32513.75
30	CONDENSATE RETURN SYSTEM	0	11100	11100	0	0	0
31	BOILER FEED SOFTENER	0	15000	19000	0	19000	0
32	P & I ENGINEERING	0	1128	1128	0	1128	1068.75
33	VIEW PORT ENLARGEMENT	0	500	500	0	500	0
20	BOILER	188000	275203	321941.5	-46738.5	310841.5	273282.25

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
41	CWF STORAGE TANK	30000	20000	9000	11000	9000	0
42	CWF PIPING MATERIALS	10000	3130	16577.67	-13447.67	16577.67	16577.67
43	CWF PIPING INSTALLATION	13000	7930	7930	0	7930	7930
44	CWF OFF-LOADING PUMP	10000	5000	4243	757	4243	4243
45	CWF TRANSFER PUMP	15000	15000	14425	575	14425	14425
46	HFO SET	0	20000	3500	16500	3500	3500
47	HFO PIPING MATERIALS/INST.	0	10000	11000	-1000	11000	11000
40	FUEL HANDLING SYSTEM	78000	81060	66675.67	14384.33	66675.67	57675.67
51	CWF ATOMIZER (NRC)	18000	12000	12000	0	12000	12000
52	HFO ATOMIZER	0	12000	7090	4910	7090	7090
53	CWF BURNER FABRICATION	26000	13955	13955	0	13955	10466.25
54	BURNER INST. STRUCTURAL MODS.	22000	13264	13264	0	13264	13181.36
55	BURNER INST. REFRACTORY MODS.	30000	19151	19151	0	19151	0
56	BURNER INSTALLATION	2000	1080	1080	0	1080	0
57	CWF IGNITOR	7000	2750	2750	0	2750	2700
58	BALANCE DRAFT DESIGN	3300	10080	10080	0	10080	10080
59	BALANCE DRAFT DUCTWORK	10000	47000	47000	0	47000	47000
60	BALANCE DRAFT INSTALLATION	7000	64917	64917	0	64917	58425.3
61	AIR HEATER	40000	52452	52452	0	52452	52452
62	ID FAN	0	37500	43500	-6000	37500	33750
63	STEAM COIL AIR HEATER	0	12016	12016	0	12016	12016
64	VIEW PORT	1200	900	900	0	900	0
50	CWF BURNER	164200	299065	300155	-1090	294155	259160.91

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CHF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.
71	COMPUTER/CONTROL SYSTEM	99000	109814	117305.6	-7491.6	117305.6	117305.6
72	TRANSMITTERS FLOW ELEMENTS	30000	24626	27755.34	-3129.34	27755.34	27755.34
73	MAGNETIC FLOWMETER	6000	8228	8228	0	5736	5736
74	CONTROL VALVES,POSITIONERS	18000	7955	7955	0	7955	7955
75	AUTO VALVES,PI'S,TI'S,ETC.	20000	12000	8185.74	3814.26	8185.74	8185.74
76	ELECTRICAL CABLE TRAYS	5000	2000	2000	0	0	0
77	SUPPLY & INST. MAIN POWER	10000	14000	8883	5117	8883	8883
78	FLAME SCANNER	0	2947	3897	-950	3897	3897
79	CHEMICAL METERING PUMP	0	3174	3174	0	3174	3174
80	E & I INSTALLATION	0	12000	12000	0	0	0
70	ELECTRICAL INSTRUMENTATION	186300	196744	199383.68	-2639.68	182091.66	182091.68
90	BONDING,PERMITS,CERTIFICATS	0	3134	3134	0	3134	0
100	PROJECT CONTINGENCY	68900	28000	0	28000	0	0
110	CAPITAL RECOVERY	0	0	0	0	N/A	0
TOTAL		779600	10063[illegible]	1109136.71	-104762.71	1060544.71	979857.37

MINUTES OF MEETING

Technical Sub-Committee of the
Minas Basin Pulp & Power CWF Conversion Steering Committee

February 9 and 10, 1988

Submitted by

Allyn Todd, P.Eng.

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Technical Sub-Committee Meeting at MBB Mechanical
February 9, 1988

Location: MBB Mechanical Services Ltd., Halifax
Date: February 9/88 - 9:00 a.m.

Attendees:

Gordon Brenton	MBPP
Dave Lawrence	MBB
Kelly Thambimuthu	CANMET
Adam Bennett	NRCC
Bob Kazmel	CBDC
Allyn Todd	CBDC

Minutes of Meeting

The group visited MBB shops at Five Island Lake to inspect the burner being modified for the Minas Basin Pulp & Power conversion.

Due to the unavailability of a meeting room, the group proceeded to NRC offices in their Atlantic Research Lab facility on Oxford Street. A list of deficiencies identified as a result of the inspection of the burner was drawn up and is presented as follows:

1. The ignitor guide tube requires fitting to the face plate.
2. Realignment of the guide tube support pipe is required to eliminate binding when adjusting primary air swirler assembly insertion depth. High temperature grease should also be employed.
3. Two remaining spider legs on the burner guide tube must be removed.
4. "OPEN " and reference numbers need to be stamped on the T-handles for primary and secondary air dampers.
5. New locating marks and numbers are needed on the burner guide tube allowing a ± 4 inch indication from the zero point.
6. New packing must be installed on the primary air damper.
7. Insulation (Mill-Board type) is to be installed on the inside surfce of the face plate with holes cut through to match holes in the face plate. Viewport tubes through the insulation are to be installed.
8. Centering ramps in burner guide tube are to be removed.

9. Burner guide tube must be cut to proper length, a critical dimension for NRC to use in determining atomizer length.

10. Main flame scanner tube to be built in through the refractory (external to the burner) to serve as a back-up in the event the location viewing through the primary swirler is not suitable.

11. A T-Handle is required on the auxiliary oil atomizer clamp for quick release capability.

12. The auxiliary oil gun guide tube is to be cut off short of entry into the necked down section of the primary air can.

13. A vane (removable) is needed for placement in the auxiliary oil gun support tube in the swirler for use when the oil gun is removed.

14. The auxiliary oil atomizer tip is to extend one inch beyond the swirler with capability of up to six inches further insertion.

15. The main oil atomizer Y-Jet tip is to be made at a 70° spray angle. This atomizer has not been fabricated yet.

The minutes of the November 28, 1987 Technical Sub-Committee meeting were reviewed and the following points noted:

A) Flex line requirements for commissioning were revised. Instead of quick disconnect lines, flex lines will be plumbed permanently in place. Two lines, 1 inch ID x 3 ft. long, stainless steel braided flex lines with 1 inch MPT fittings on both ends are required. MBP&P will supply, not CANMET as previously agreed.

B) Negative boiler pressure eliminates the need for air sealing between atomizer and burner guide tube.

C) Refractory must be kept from freezing prior to installation. Refractory will be of 80% alumina content and a fibreboard of expanded fibre-fill (ordered from B&W) will be on site in the event tube wall shielding is required.

D) Viewports are on site now for the rear and side of the boiler. Sealing air and a view damper are also provided.

E) MBB will quote on a thermocouple to be installed at rear of boiler to measure gas temperature. Shielding will not be required. Radiation error is expected to be 100-150°F.

F) Drawings are not required by Bailey in order to supply flame scanner mounting hardware. MBB will ensure that the scanners are properly mounted on the burner.

During the afternoon session, the CANMET burner drawings, drawn by MBB using AutoCad, were checked for proper detail and changes required for the MECL 5 burner test scheduled for this summer. The following major points were noted:

1. The primary air can divergent section is to be deleted and the design will only incorporate the straight section.
2. Primary air swirl vanes shall be reversed from position shown so as to impart CCW swirl.
3. For MECL the 14½" swirler drawings will be included but only the 13½" will be fabricated.
4. The secondary air damper pointers will be modified to point close to the scale so as to minimize parallax error.
5. The secondary air wall support bars will be relocated as per original drawing to allow full 360° rotation of vanes. Scales to remain as is with 0° = fully open.
6. Primary and secondary air damper pointers to be deleted and the end of the nipple through which the rod goes will become the datum point. Reference notches in rod will require relocating.
7. The auxiliary oil gun hole in burner plate and in primary swirler is not required for MECL.
8. Ignitor position at 10:00 is o.k.
9. The swirler carrier tube will be shortened to reflect the new length as per drawings.

A final review of modified drawings will be required. This is scheduled for February 24/88, 1:00 p.m. at MBB Mechanical offices. MBB agreed to send the modified drawings to CANMET (for preview) by courier on February 19/88.

On Wednesday, February 10/88, the group (except Gordon Brenton) returned to the MBB shop to obtain the new burner guide tube length from which NRC will determine atomizer length. This was followed by a visit to Minas Basin Pulp and Power to observe progress. An inspection of the boiler furnace enabled location of the tube which will be bent for viewport access and approximate location of the flame scanner sight tube.

Submitted by ______________________
Allyn Todd

1988-02-23

AT:mlm

c.c. - Attendees
Mr. A. White
Mr. L. MacNeil, NSDME
Mr. J. MacLean

CERTIFICATE
NUMBER 027/A

PROVINCE OF NOVA SCOTIA

Department of Labour and Manpower

PLANT REGISTRATION CERTIFICATE

This is to Certify That the Plant known as:

MINAS BASIN PULP AND POWER

LOCATED AT HANTSPORT, NOVA SCOTIA AND OWNED BY MINAS BASIN PULP AND POWER

HAS BEEN DULY REGISTERED UNDER THE PROVISIONS OF SECTION 5 SUB-SECTION 4 OF AN ACT RESPECTING STATIONARY ENGINEERS, S.N.S. 1980, CHAPTER 18 (REPLACING ENGINE OPERATORS ACT) AND REGULATIONS AS CONSISTING OF:

BOILER PLANT - HIGH PRESSURE	...2247.7 B.H.P.
BOILER PLANT - LOW PRESSURE	B.H.P.
BOILER PLANT COMBINED	B.H.P.
REFRIGERATOR PLANT	M.H.P.
COMPRESSOR PLANT (AIR)	.......400.....M.H.P.
HOISTING PLANT	M.H.P.

CERTIFICATE(S) REQUIRED FOR CHIEF STATIONARY ENGINEER
STATIONARY ENGINEER - FIRST CLASS

CERTIFICATE(S) REQUIRED FOR SHIFT STATIONARY ENGINEER
STATIONARY ENGINEER - SECOND CLASS

CHAIRMAN, BOARD OF EXAMINERS

Terence R. B. Donahoe
MINISTER OF LABOUR AND MANPOWER

HALIFAX, N.S.
FEBRUARY 16, 1988

NOTICE: This certificate must at all time be prominently displayed in a suitable and safe place on the plant premises. Re-registration is necessary only when a change has been made in the horse-power of the plant or when same has changed ownership.

FILE NO. ____________
PLANT NO. ____________
DATE Feb 24/88

NOVA SCOTIA
DEPARTMENT OF LABOUR

STEAM BOILER AND PRESSURE VESSEL ACT

Certificate of Inspection

NAME MINAS BASIN PULP & POWER
ADDRESS HANTSPORT, HANTS CO. N.S.

THIS CERTIFICATE MUST BE RETAINED IN A SUITABLE AND SAFE LOCATION READILY ACCESSIBLE TO AN INSPECTOR.

NUMBER	SIZE	HEATING SURFACE	TYPE	LOCATION	APPROVED PRESSURE
71210		4072			250

INSTALLATION COMPLIES WITH THE REQUIREMENTS OF THE STEAM BOILER AND PRESSURE VESSEL ACT.

Eric Mitchell INSPECTOR

STEAM BOILER AND PRESSURE VESSEL ACT

DIRECTIVES NOS. SHALL BE COMPLETED WITHIN DAY.

Blr. and associated piping inspected and hydrostatically tested No leakage observed.
Test pressure 325 PSI.
18 Ft. of 2" Pipe 16 welds pumps to control station
28 Ft of 2½" Pipe 28 welds station to boi
Steam Line From Boiler - Approx. 40 FT.
10 - 6" WELDS, 11 - 8" WELDS - Approx 50 FT. 2"

S.V.	YEAR	INT.	EXT.	LEGEND			LEGEND			LEGEND			FEE NO	FEES

TOTAL FEE $ ____________

LOCATION ____________

INVOICE MBB. MECH. HFX.

FILE NO. ____________

PLANT NO. ____________

DATE MAR 4/88

NOVA SCOTIA
DEPARTMENT OF LABOUR

STEAM BOILER AND PRESSURE VESSEL ACT

Certificate of Inspection

NAME MINAS BASIN PULP + POWER

ADDRESS HANTSPORT, KINGS CO. N.S.

THIS CERTIFICATE MUST BE RETAINED IN A SUITABLE AND SAFE LOCATION READILY ACCESSIBLE TO AN INSPECTOR.

NUMBER	SIZE	HEATING SURFACE	TYPE	LOCATION	APPROVED PRESSURE

INSTALLATION COMPLIES WITH THE REQUIREMENTS OF THE STEAM BOILER AND PRESSURE VESSEL ACT.

____________ INSPECTOR

STEAM BOILER AND PRESSURE VESSEL ACT

DIRECTIVES NOS. SHALL BE COMPLETED WITHIN DAYS

Piping from No 7 Blr to #6 BL MAIN

STEAM LINE APPROX 20' 8" + 5' of 6"

Test pressure 250 PSI

NO LEAKAGE OBSERVED

S.V.	YEAR	INT.	EXT.	LEGEND			LEGEND			LEGEND			FEE NO	FEES

TOTAL FEE $ ____

LOCATION GORDEN STATES WELDING SHOP

INVOICE AS ABOVE.

TJ INSPECTION SERVICES

P.O. Box 3088
Dartmouth, N.S.
B2W 4Y3
902-434-2589

WELDING INSPECTION
SURFACE & UNDERWATER NDT
QC/QA SERVICES

INSPECTION REPORT

Report No. RR 633
Date 6 Mar 88
Client P.O.

Client MINAS BASIN PULP & POWER CO. LTD.
53 Prince St., Hantsport B0P 1P0

Job Description DEAREATOR INSPECTION

MAGNETIC PARTICLE INSPECTION

METHOD
A.C. Continuous - Wet

SPECIFICATION
ASME Sec VIII

EQUIPMENT
Parker Contour Probe
Magnaflux B100A UV Lamp
Ardrox 8510 Fluorescent Indicator

TECHNIQUE PARAMETERS

Medium Application	Wet	Spray
Coverage	100%	Weld & HAZ
Demagnetization	Not Required	

SURFACE PREPARATION

All welds were inspected from the inside surface of the vessel. All areas were brushed clean, removing all scale and foreign matter.

OBJECT UNDER TEST

The inspection was performed on all welds for the deaerator vessel. This included the vessel longitudinal and circumferential seams, as well as all penetration welds.

OBSERVATIONS

No indications were observed which could be interpreted as cracks or rejectable surface indications. All examinations were performed using ultraviolet light.

FINAL RESULT

All areas inspected met the requirements of ASME Section VIII.

for Client

TJ

Government of Canada
Gouvernement du Canada

Cape Breton Development Corporation
Société de développement du Cap-Breton

CONTRACT SERIAL NUMBER 79014-01-SQ

REQUISITION NUMBER 23440-7-9014

CONTRACTOR: CAPE BRETON DEVELOPMENT CORP.

COAL WATER FUEL CONVERSION OF AN INDUSTRIAL OIL-DESIGNED PACKAGE BOILER IN A PULP AND PAPER PLANT, HANTSPORT, N.S.

APPENDIX E - 0

313 pp

APPENDIX E

MINUTES OF THE TECHNICAL STEERING COMMITTEE

CARBOFUEL - MINAS BASIN PROJECT

MINUTES

Steering Committee Meeting No. 1
August 13, 1987

Attendees:

Ed Bain, N.S. Dept. of Mines and Energy, Chairman
Adrian White, Cape Breton Development Corporation
Kelly Thambimuthu, CANMET
Phil Read, Energy, Mines & Resources, Canada
Audbrey Palmeter, Minas Basin Pulp & Power Co. Ltd.
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Lorne MacNeil, Canada-N.S. Oil Substitution Fund

1. Review of Project and Goals

Mr. Adrian White reviewed the project and its goals. The Cape Breton Development Corporation (CBDC) has a pilot plant capable of producing 35,000 tonnes of Carbofuel per year. CBDC would like to develop an ongoing demonstration project to assist in marketing Carbofuel and to provide the incentive to construct a larger plant which will reduce the production costs.

Minas Basin Pulp & Power are interested in up-grading their boiler system and would prefer to use a non-oil fuel. It is expected that this boiler will consume approximately 16,000 tonnes of Carbofuel per year.

2. Contracts

Mr. Ed Bain reviewed the highlights of the CBDC/Nova Scotia (Oil Substitution) contract. Several items were discussed by the Committee.

As per section 4(2) of the contract, CBDC intend to subcontract to Minas Basin Pulp & Power who in turn will be subcontracting to (a) MBB Mechanical Services Ltd., (b) J. W. Lindsay Construction Ltd. and (c) Jacques Whitford & Associates Ltd. The Committee approved the use of these subcontractors.

Dr. Read suggested, and the Committee agreed, that since it would not always be possible to hold meetings prior to decision on certain items, written consent via telex or FAX would be an acceptable way of showing approval.

The monthly reports required under Section 6 should include expenditures to date, achievements, problems, etc. An interim report is expected by April 1988 with a final report due by December 1988. It is still felt the boiler can be commissioned by March 1988.

Dr. Thambimuthu briefly described the CANMET contract with CBDC. In essence, CANMET is purchasing a report on the performance of their burner.

A secrecy agreement has also been signed by CBDC and CANMET to protect CANMET's properietary burner Technology. Under this agreement CBDC and CANMET will share any arising information which results in burner improvements.

Dr. Read pointed out a potential discrepancy may exist between the Oil Substitution contract and this agreement since unnder Section 9 of the Oil Substitution contract, the Contractor (CBDC) shall own all intellectual property arising out of the Project. It was agreed however, that CBDC's lawyer should confirm that there is no conflict between the two contracts.

Aubrey Palmeter commented briefly on the Minas Basin Pulp & Power/CBDC contract. Under this agreement CBDC will provide a boiler and supply Carbofuel at a price equivalent to the current oil price. In return Minas Basin Pulp & Power will allow CBDC to conduct tours of this demonstration project to promote the use of Carbofuel. Mr. Palmeter also noted that Mr. Zwicker will be taking over as the Minas Basin Pulp & Power representative for this Committee.

3. Invoices/Payments

Mr. Adrian White presented a revised cost estimate and a cash flow for this project (copy attached). Mr. White noted that there was one major change from the original budget. It is now planned to install the Carbofuel boiler on a new site, rather than replacing an existing boiler. This has raised the cost of civil site preparation from $66,400 to $105,000. The overall budget has gone from $957,900 to $974,000.

Discussion took place on how invoices and payments will be handled. It was agreed that Minas Basin Pulp & Power would be responsible for making payments to all the subcontractors. Minas Basin Pulp & Power will then submit the original invoices to CBDC for reimbursement. CBDC will retain all original invoices and will submit copies of paid invoices totalling $358,000 to Lorne MacNeil who will arrange for payment from the Oil Substitution Fund. Dr. Thambimuthu indicated that while CANMET will review invoices to confirm all the expenditures for the total project have been made, their payments to CBDC will be made as follows:

(1) $225,000 when the boiler is commissioned
(2) $40,000 when the interim report is received
(3) $35,000 when the final report is received.

4. Project Phases/Progress to Date

The Committee reviewed the project phases, as laid out in the cost estimates. Section 10, Civil Site Preparation, is currently underway. Most of the work will be carried out by J. W. Lindsay Construction Ltd. Jacques Whitford & Associates Ltd. has carried out soil testing for the foundation, and Minas Basin Pulp & Power will be handling the control room. This section is expected to be completed by the next meeting.

Section 20, Boiler, is underway and is being carried out by MBB Mechanical Services Ltd. This section is expected to be half completed by the next meeting.

Sections 40 & 50, the Fuel Handling System and the CWF Burner will also be looked after by MBB, although CBDC will be ordering the atomizer. The boiler controls in Section 70 are expected to be supplied by Bailey Controls, and the remaining equipment will come from various sources.

5. Press Releases

The Committee agreed there should not be a press release until after the boiler is commissioned. Press releases will be shown to all parties and discussed via conference call prior to being issued. There is also the possibility of papers being presented at the Coal Water Slurry Conference, the IEA Conference in Japan, or the Pulp and Paper Conference.

6. Other

Questions were raised during the meeting regarding burner configuration and emission controls. The single CWF burner will be in the middle of the three oil fired burners. Ignition will be carried out using propane. Dr. Kelly Thambimuthu will be informed when the burner is ready for inspection.

Mr. Adrian White informed the Committee that CBDC would be monitoring both new and existing stacks to obtain a comparison of the emissions from coal, wood, and oil. Any discussions with Environment Canada will explain the demonstration nature of this project and outline these plans to monitor the stack to determine what equipment, if any, will be required for stack cleaning. It is thought that particulate will be too fine for a cyclone to be effective. Capacity has been built into the balance draft system to supply sufficient pressure for a bag house but funds have not been allocated in the budget. It was estimated that a baghouse will cost $150,000; quotes should be received before the next meeting. It is also possible the baghouse used at Chatham could be obtained but expenses would still be incurred to disassemble, transport and reassemble.

The next meeting of the Steering Committee was set for 9:30 a.m. on Wednesday, September 30, 1987 at the Minas Basin Pulp & Power site in Hantsport.

The meeting concluded with a video presentation by Dr. Thambimuthu showing some of the test burns being carried out in Charlottetown.

C.B.CARBOFUEL LTD.

PROCESS
JUL
TECHNOLOGY

MINAS PULP & POWER COAL WATER CONVERSION

Unit	Description	Original Budget	Revised Budget	Actual	Variance	Sum Of Req.Amt.	Sum Of Inv.Amt.	Est. To Comp.
11	BOILER ROOM FLOOR	20,000.00	20,000.00	0.00	(20,000.00)	0.00	0.00	0.00
12	FOUNDATION/STACK & FANS	25,000.00	25,000.00	0.00	(25,000.00)	0.00	0.00	0.00
13	BOILER HOUSE	45,000.00	45,000.00	0.00	(45,000.00)	0.00	0.00	0.00
14	CONTROL ROOM/ A/C	5,000.00	8,000.00	0.00	(8,000.00)	0.00	0.00	0.00
15	MEZZANINE/STAIRWELL	2,500.00	5,000.00	0.00	(5,000.00)	0.00	0.00	0.00
16	PAINTING MAT/LAB	2,500.00	2,000.00	0.00	(2,000.00)	0.00	0.00	0.00
10	CIVIL SITE PREPARATION	100,000.00	105,000.00	0.00	(105,000.00)	0.00	0.00	0.00
21	BOILER PURCHASE	60,000.00	60,000.00	0.00	(60,000.00)	0.00	0.00	0.00
22	STACK REMOVAL	2,000.00	6,025.00	0.00	(6,025.00)	0.00	0.00	0.00
23	STACK TRANSPORT	1,000.00	880.00	0.00	(880.00)	0.00	0.00	0.00
24	STACK INSTALLATION	6,000.00	8,200.00	0.00	(8,200.00)	0.00	0.00	0.00
25	BOILER REMOVAL	12,000.00	29,125.00	0.00	(29,125.00)	0.00	0.00	0.00
26	BOILER TRANSPORT	7,000.00	6,680.00	0.00	(6,680.00)	0.00	0.00	0.00
27	BOILER INSTALLATION	44,000.00	52,208.00	0.00	(52,208.00)	0.00	0.00	0.00
28	MECHANICAL MATERIALS	10,000.00	35,960.00	0.00	(35,960.00)	0.00	0.00	0.00
29	MECHANICAL INSTALLATION	46,000.00	34,226.00	0.00	(34,226.00)	0.00	0.00	0.00
30	CONDENSATE RETURN SYSTEM	0.00	11,100.00	0.00	(11,100.00)	0.00	0.00	0.00
31	BOILER FEED SOFTENER	0.00	15,000.00	0.00	(15,000.00)	0.00	0.00	0.00
32	STEAM HEADER VALVE/REPAIR	0.00	1,000.00	0.00	(1,000.00)	0.00	0.00	0.00
33	P & I ENGINEERING	0.00	1,128.00	0.00	(1,128.00)	0.00	0.00	0.00
34	VIEW PORT ENLARGEMENT	0.00	500.00	0.00	(500.00)	0.00	0.00	0.00
20	BOILER	188,000.00	262,032.00	0.00	(262,032.00)	0.00	0.00	0.00
41	CWF STORAGE TANK	30,000.00	20,000.00	0.00	(20,000.00)	0.00	0.00	0.00
42	CWF PIPING MATERIALS	10,000.00	3,130.00	0.00	(3,130.00)	0.00	0.00	0.00
43	CWF PIPING INSTALLATION	13,000.00	7,930.00	0.00	(7,930.00)	0.00	0.00	0.00
44	CWF OFF-LOADING PUMP	10,000.00	5,000.00	0.00	(5,000.00)	0.00	0.00	0.00
45	CWF TRANSFER PUMP	15,000.00	15,000.00	0.00	(15,000.00)	0.00	0.00	0.00
46	HFO SET	0.00	20,000.00	0.00	(20,000.00)	0.00	0.00	0.00
47	HFO PIPING MATERIALS/INST.	0.00	10,000.00	0.00	(10,000.00)	0.00	0.00	0.00

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MINAS PULP & POWER COAL WATER CONVERSION

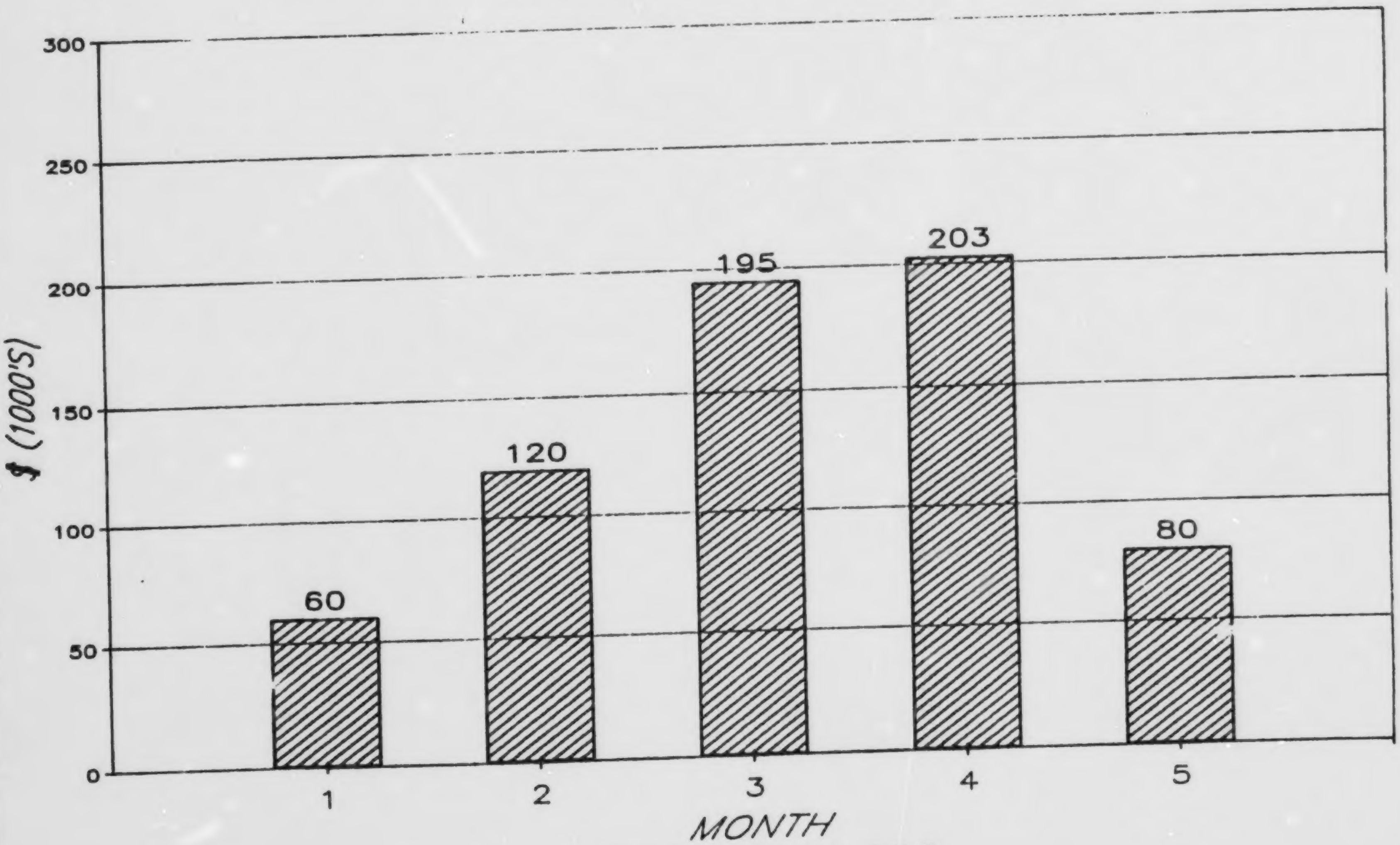
Unit	Description	Original Budget	Revised Budget	Actual	Variance	Sum Of Req.Amt.	Sum Of Inv.Amt.	Est. To Comp.
40	FUEL HANDLING SYSTEM	78,000.00	81,060.00	0.00	(81,060.00)	0.00	0.00	0.00
51	CWF ATOMIZER (BRC)	18,000.00	18,000.00	0.00	(18,000.00)	0.00	0.00	0.00
52	HFO ATOMIZER	0.00	4,000.00	0.00	(4,000.00)	0.00	0.00	0.00
53	CWF BURNER FABRICATION	24,000.00	13,955.00	0.00	(13,955.00)	0.00	0.00	0.00
54	BURNER INST.STRUCTURAL MODS	22,000.00	13,264.00	0.00	(13,264.00)	0.00	0.00	0.00
55	BURNER INST.REFRACTORY MODS	30,000.00	19,151.00	0.00	(19,151.00)	0.00	0.00	0.00
56	BURNER INSTALLATION	2,000.00	1,080.00	0.00	(1,080.00)	0.00	0.00	0.00
57	CWF IGNITOR	7,000.00	2,750.00	0.00	(2,750.00)	0.00	0.00	0.00
58	BALANCE DRAFT DESIGN	3,000.00	10,080.00	0.00	(10,080.00)	0.00	0.00	0.00
59	BALANCE DRAFT DUCTWORK	10,000.00	47,000.00	0.00	(47,000.00)	0.00	0.00	0.00
60	BALANCE DRAFT INSTALLATION	7,000.00	64,917.00	0.00	(64,917.00)	0.00	0.00	0.00
61	AIR HEATER	40,000.00	52,452.00	0.00	(52,452.00)	0.00	0.00	0.00
62	ID FAN	0.00	37,500.00	0.00	(37,500.00)	0.00	0.00	0.00
63	STEAM COIL AIR HEATER	0.00	12,016.00	0.00	(12,016.00)	0.00	0.00	0.00
64	VIEW PORTS	1,200.00	1,200.00	0.00	(1,200.00)	0.00	0.00	0.00
50	CWF BURNER	164,200.00	297,365.00	0.00	(297,365.00)	0.00	0.00	0.00
71	CONTROLLER,PANEL,ECT.	35,000.00	43,838.00	0.00	(43,838.00)	0.00	0.00	0.00
72	BURNER MANAGEMENT LOGIC	30,000.00	35,000.00	0.00	(35,000.00)	0.00	0.00	0.00
73	DATA ACQUISITION	34,000.00	34,000.00	0.00	(34,000.00)	0.00	0.00	0.00
74	TRANSMITTERS FLOW ELEMENTS	30,000.00	24,326.00	0.00	(24,326.00)	0.00	0.00	0.00
75	MAGNETIC FLOWMETER	6,000.00	8,228.00	0.00	(8,228.00)	0.00	0.00	0.00
76	CONTROL VALVES,POSITIONERS	18,000.00	7,955.00	0.00	(7,955.00)	0.00	0.00	0.00
77	AUTO VALVES,PI'S,TI'S,ECT.	20,000.00	12,000.00	0.00	(12,000.00)	0.00	0.00	0.00
78	ELECTRICAL CABLE TRAYS	5,000.00	2,000.00	0.00	(2,000.00)	0.00	0.00	0.00
79	SUPPLY & INST.MAIN POWER	10,000.00	14,000.00	0.00	(14,000.00)	0.00	0.00	0.00
80	FLAME SCANNER	0.00	2,947.00	0.00	(2,947.00)	0.00	0.00	0.00
81	CHEMICAL METERING PUMP	0.00	2,076.00	0.00	(2,076.00)	0.00	0.00	0.00
82	E & I INSTALLATION	0.00	12,000.00	0.00	(12,000.00)	0.00	0.00	0.00

C.B.CARBOFUEL LTD.

MINAS PULP & POWER COAL WATER CONVERSION

Unit	Description	Original Budget	Revised Budget	Actual	Variance	Sum Of Req.Amt.	Sum Of Inv.Amt.	Est. To Comp.
70	ELECTRICAL INSTRUMENTATION	188,000.00	198,370.00	0.00	(198,370.00)	0.00	0.00	0.00
91		0.00	3,134.00	0.00	(3,134.00)	0.00	0.00	0.00
90	BONDING,PERMITS,CERTIFICATES.	0.00	3,134.00	0.00	(3,134.00)	0.00	0.00	0.00
101		68,900.00	27,939.00	0.00	(27,939.00)	0.00	0.00	0.00
100	PROJECT CONTINGENCY	68,900.00	27,939.00	0.00	(27,939.00)	0.00	0.00	0.00
111		0.00	0.00	0.00	0.00	0.00	0.00	0.00
110	CAPITAL RECOVERY	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL		787,100.00	974,900.00	0.00	(974,900.00)	0.00	0.00	0.00

MINAS PULP & POWER CWF CONVERSION
CASH FLOW
CBDC SHARE



TOTAL $658,000

CARBOFUEL - MINAS BASIN PROJECT MINUTES

Steering Committee Meeting No. 2
September 30, 1987

Attendees:

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Bob Kassel, Cape Breton Development Corporation
Kelly Thambimuthu, CANMET
Adrian White, Cape Breton Development Corporation
Phil Read, Energy, Mines & Resources, Canada
Lorne MacNeil, Canada-N.S. Oil Substitution Fund

1. Business from the Last Meeting

The minutes of the last meeting were reviewed and several questions were answered. (1) The first monthly progress report was presented and is attached to these minutes. (2) Cape Breton Development Corporation's lawyer has reviewed the contracts and has concluded no conflict exists. (3) Quotes have been received from several manufacturers of stack cleaning equipment. These have also been attached to these minutes.

2. Review of Budget

The Committee reviewed Project Report #1. A number of cost overruns have already been experienced on this project. The expected overruns to date are:

Civil Site Preparation	$25,000
Early Boiler Removal	$ 4,666
CN Flat Bed Demurrage	700
	$30,366

It was also anticipated that there may be a fire water line at the civil site which will have to be relocated.

Since the budgeted contingency for this project is only $20,000.00, it appears additional funding will be required to complete the project.

Mr. Adrian White will be writing to the Oil Substitution Fund Management Committee, c/o Lorne MacNeil to indicate additional monies may be requested.

3. Review of Schedule

Mr. Bob Kassel reviewed the project schedule. A number of delays have already been experienced but the start up of the heating system is now planned for January 12, 1988 which only represents a one week delay.

Mr. Ed Bain expressed some concern about the schedule. Item 10, civil site preparation was expected to be finished by this meeting but is only about 20% complete. Item 20, Boiler, should have been 50% complete but is thought to be 10% complete. Dr. Kelly Thambimuthu also noted that portions of the CANMET funding must be spent by the end of March.

It was agreed that Mr. Kasmel should stay in close contact with the contractors and make them aware of the urgency of maintaining the project schedule. It was also felt it may be useful to have the contractors attend the next Steering Committee meeting.

4. Emission Controls

Mr. Adrian White reviewed the quotes which have been received from stack cleaning equipment. No decision will be made however until after some stack analysis has been carried out to determine what sort of emission controls are required.

Mr. Peter Zwicker informed the Committee he has been in contact with Environment Canada but has not filed a final application with them as yet.

Dr. Phil Reed noted that the cyclones used during the Chatham tests had not removed any ash at all. He suggested this approach should not be considered. Dr. Thambimuther indicated he would be doing some work during November to determine what sort of ash removal system would be most effective.

5. Technical Advisory Group

Dr. Kelly Thambimuther suggested an ad hoc committee be formed to help solve problems as they arise. This committee would include members from NRC, CANMET (Dr. Thambimuther), CBDC (Joel MacLean, Allyn Todd), MBB, etc. who could be called upon to resolve questions in their own field of expertise. Members of the Technical Advisory Group will advise the project manager (Bob Kasmel) who in turn will report to the Steering Committee.

The Steering Committee agreed with this approach.

6. Other

The next Steering Committee meeting is scheduled for 9:30 a.m. on Wednesday, November 18, 1987 at the Minas Basin Pulp & Power site in Hantsport.

MINAS BASIN PULP & POWER

CWF CONVERSION

PROJECT REPORT #1

1987-09-30

DISTRIBUTION

MEMBERS OF STEERING COMMITTEE

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Kelly Thambimuthu, CANMET
Phil Read, Energy, Mines & Resources, Canada
Audbrey Palmeter, Minas Basin Pulp & Power Co. Ltd.
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Lorne MacNeil, Canada-N.S. Oil Substitution Fund
Adrian White, Cape Breton Development Corporation

Prepared by:

Robert Kazmel
Joel MacLean

As noted during the first steering committee meeting of 1987-08-13, J.W. Lindsay Enterprises Ltd. has been awarded the CWF site preparation contract by Minas Pulp & Power Ltd. Lindsay in turn has subcontracted the foundation design work to George Brandy's & Associated. Since that time, two (2) project meetings have taken place with Lindsay representatives.

The expected cost overrides on the civil work include:

1. Base for ID fan - this information was not provided on the original plan by MBB - estimated cost is: $5,000.00.
2. MBB has requested that the stack base height be level with the finished floor, not at finished grade - estimated cost: $3,000.00.
3. Floor drains and oil separator for the boiler room floor along with a sump in the CWF storage pit - estimated cost: $2,000.00.
4. Jacques Whitford to supply a soils engineer - estimated cost: $3,000.00.
5. ~~CWF~~ CKF effluent line relocation - estimated cost: $12,000.00.
6. Water line

Expected cost overrides for the civil site preparation is approximately: $25,000.00.

The estimated time required for the civil site preparation is seven (7) weeks including two (2) week minimum to cure.

The Cape Breton Development Corporation issued a purchase order for the AECL boiler on 1987-05-08. The purchased items were:

1. Steam generator including FD fan;
2. blow off tank;
3. boiler stack;
4. two (2) feedwater pumps and motors;
5. deaerator;
6. chemical mix tank;
7. chemical mixer.

Due to a request by Nova Aqua, (the company holding a lease on the AECL building in which the boiler was housed), the boiler was removed ~~for~~ its footings ahead of schedule. The cost extra for the early removal was $4,666.00. Minas Basin has purchased two

(2) used 12 X 20 ft. CWF storage tanks. At the time of writing no~~t~~ cost has been supplied to CBDC for these tanks. ($9000 for both) $4500 ea

On 1987-09-14 MBB Mechanical started dismantling and preparing for transport the boiler. stack and auxiliary equipment. The boiler is ~~are~~ currently sitting on a CN flat bed at the AECL site. The stack was shipped by road to Minas on 1987-09-15 and the boiler auxiliary equipment arrived at Five Islands on 1987-09-24.

On 1987-09-23 Minas removed the underground day tank and Lindsay were to commence excavation. Removed on 28th of Sept.

Currently, all materials required to operate and control the boiler are ordered and some materials have been received. For the control system, we have taken delivery of the necessary computer hardware, the PCW/LAN90 software from Bailey and the QNX operating system from Quantum.

An initial draft of the modulating control configuration required for the COM03 control modules on the network 90 have been developed. The final analog configuration will be determined after consultation with Bailey. This consultation is necessary, since the logic control that Bailey is developing and the modulating controls that are developing have some common points.

The QNX operating system has been booted on two (2) computers and we are currently experimenting with modern communications and file transfer methods available on QNX. We are also developing the configuration of the PCW/LAN90 software.

On 1987-09-15 representatives of Canmet, NRC and MBB attended a project meeting. The purpose of which was:

1. Review of Canmet/NRC burner performance at MECL.
2. Discussion of changes to burner design for application in Minas Basin.
3. Review of Minas Basin project schedule.

Minor modifications to the original piping arrangements have been made and these have been relayed to MBB Mechanical.

Commitments to date include:

1.	J.W. Lindsay Enterprises Ltd.	$105,188.00
2.	MBB Mechanical Services	$446,557.00
3.	CBDC supplied equipment	$296,440.44

4. Minas supplied equipment	Not Available
Total to date	$848,185.44
Contract changes to date	$ 30.366.00

Attached you will find project schedule and project budget.

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.	EST. TO CO
11	FOUNDATION/STACK & FANS	30000	15620	15620	0	15620	0	0
12	BOILER HOUSE / FOUNDATION	55000	90568	89568	1000	89568	0	0
13	CONTROL ROOM A/C	5000	8000	8000	0	0	0	8000
14	PAINTING MAT/LAB	2500	7000	7000	0	0	0	7000
10	CIVIL SITE PREPARATION	92500	121188	120188	1000	105188	0	15000
21	BOILER PURCHASE	60000	60000	60000	0	60000	0	0
22	STACK REMOVAL	2000	6025	6025	0	6025	0	0
23	STACK TRANSPORT	1000	880	880	0	880	0	0
24	STACK INSTALLATION	6000	8200	8200	0	8200	0	0
25	BOILER REMOVAL	12000	33791	38457	-4666	33791	0	4666
26	BOILER TRANSPORT	7000	6680	6680	0	6680	0	0
27	BOILER INSTALLATION	64000	52208	52890	-682	52890	0	0
28	MECHANICAL MATERIALS	10000	50131	50130.1	0.9	50130.15	0	-0.05
29	MECHANICAL INSTALLATION	64000	34226	34226	0	34226	0	0
30	CONDENSATE RETURN SYSTEM	0	11100	11100	0	0	0	11100
31	BOILER FEED SOFTENER	0	15000	15000	0	0	0	15000
32	P & I ENGINEERING	0	1128	1128	0	1128	0	0
33	VIEW PORT ENLARGEMENT	0	500	500	0	500	0	0
20	BOILER	188000	279869	285216.1	-5347.1	254450.15	0	30765.95

CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CWF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.	EST. TO CO
41	CWF STORAGE TANK	30000	20000	20000	0	0	0	20000
42	CWF PIPING MATERIALS	10000	3130	3130	0	3130	0	0
43	CWF PIPING INSTALLATION	13000	7930	7930	0	7930	0	0
44	CWF OFF-LOADING PUMP	10000	5000	5000	0	0	0	5000
45	CWF TRANSFER PUMP	15000	15000	15000	0	14425	0	575
46	HFO SET	0	20000	20000	0	0	0	20000
47	HFO PIPING MATERIALS/INST.	0	10000	10000	0	0	0	10000
40	FUEL HANDLING SYSTEM	78000	81060	81060	0	25485	0	55575
51	CWF ATOMIZER (NRC)	18000	12000	12000	0	12000	0	0
52	HFO ATOMIZER	0	12000	12000	0	0	0	12000
53	CWF BURNER FABRICATION	24000	13955	13955	0	13955	0	0
54	BURNER INST. STRUCTURAL MODS.	22000	13264	13264	0	13264	0	0
55	BURNER INST. REFRACTORY MODS.	30000	19151	19151	0	19151	0	0
56	BURNER INSTALLATION	2000	1080	1080	0	1080	0	0
57	CWF IGNITOR	7000	2750	2750	0	2750	0	0
58	BALANCE DRAFT DESIGN	3000	10080	10080	0	10080	0	0
59	BALANCE DRAFT DUCTWORK	10000	47000	47000	0	47000	0	0
60	BALANCE DRAFT INSTALLATION	7000	64917	64917	0	64917	0	0
61	AIR HEATER	40000	52452	52452	0	52452	0	0
62	ID FAN	0	37500	37500	0	37500	0	0
63	STEAM COIL AIR HEATER	0	12016	12016	0	12016	0	0
64	VIEW PORT	1200	900	900	0	900	0	0
50	CWF BURNER	164200	299065	299065	0	287065	0	12000

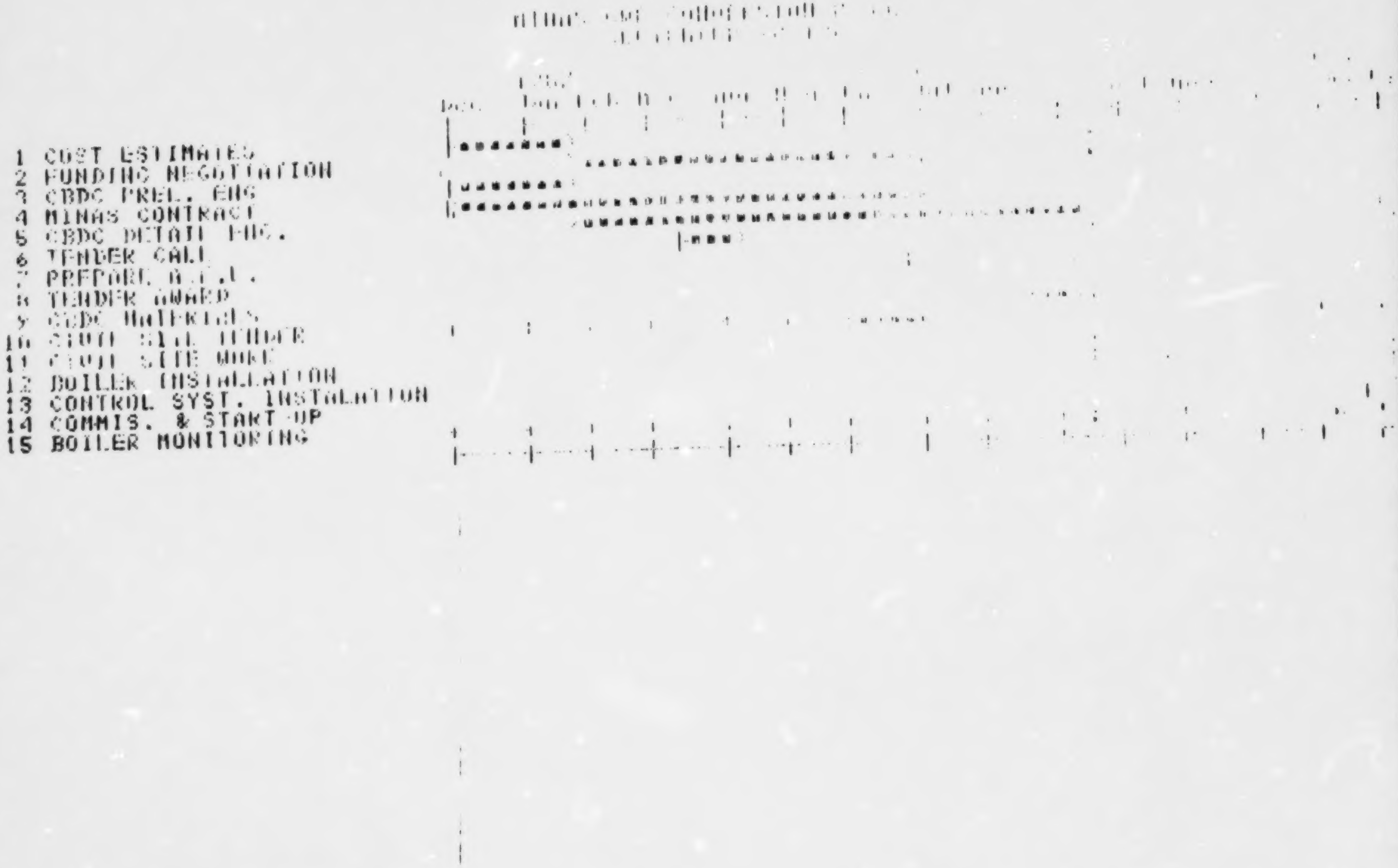
CAPE BRETON DEVELOPMENT CORPORATION

MINAS BASIN PULP AND POWER

CUF CONVERSION

1987

UNIT	DESCRIPTION	ORIGINAL BUDGET	REVISED BUDGET	ACTUAL BUDGET	VARIANCE	SUM OF REQ.	SUM OF INV.	EST. TO CO
71	COMPUTER/CONTROL SYSTEM	99000	109814	110341	-527	110341	0	0
72	TRANSMITTERS FLOW ELEMENTS	30000	24626	24626	0	24559	0	67
73	MAGNETIC FLOWMETER	6000	8228	8228	0	5736	0	2492
74	CONTROL VALVES,POSITIONERS	18000	7955	7955	0	7955	0	0
75	AUTO VALVES.PI'S.TI'S.ETC.	20000	12000	12000	0	11043.29	0	956.71
76	ELECTRICAL CABLE TRAYS	5000	2000	2000	0	0	0	2000
77	SUPPLY & INST. MAIN POWER	10000	14000	14000	0	7108	0	6892
78	FLAME SCANNER	0	2947	2947	0	2947	0	0
79	CHEMICAL METERING PUMP	0	3174	3174	0	3174	0	0
80	E & I INSTALLATION	0	12000	12000	0	0	0	12000
70	ELECTRICAL INSTRUMENTATION	188000	196744	197271	-527	172863.29	0	24407.71
90	BONDING.PERMITS.CERTIFICATS	0	3134	3134	0	3134	0	0
100	PROJECT CONTINGENCY	62900	28000	0	28000	0	0	0
110	CAPITAL RECOVERY	0	0	0	0	N/A	0	0
TOTAL		779600	1009060	985934.1	23125.9	848185.44	0	137762.64


1 COST ESTIMATES
2 FUNDING NEGOTIATION
3 CBDC PREL. ENG
4 MINAS CONTRACT
5 CBDC DETAIL ENG.
6 TENDER CALL
7 PREPARE A.F.I.
8 TENDER AWARD
9 CBDC MATERIALS
10 CIVIL SITE TENDER
11 CIVIL SITE WORK
12 BOILER INSTALLATION
13 CONTROL SYST. INSTALLATION
14 COMMIS. & START UP
15 BOILER MONITORING
Dec.
Jan
Feb
Mar
Apr
May
Jun
Jul

DEVELOPMENT
CORPORATION

YOUR FILE No.
Votre dossier

TO
A Mr. A. White

OUR FILE No.
Notre dossier

FROM
De A.Todd

DATE 1987-09-21

SUBJECT
Sujet **MBP&P BAGHOUSE QUOTATIONS**

Attached are summary sheets based on information received from six potential suppliers of baghouses, ESP's or scrubbers for the MBP&P project. The following table summarizes the quotations received to date.

Baghouse Quotations

Supplier	Unit Type	Unit Cost	Del. Cost
Cantech	Baghouse	$ 118,500	$ 6,000
Flakt Can.	ESP	400,000 installed	
Mikropul Ltd.	Baghouse	98,977	10,000
Air Correction	Baghouse	72,990	N/A
Air Correction	Multicyclone	40,415	N/A
Hydrosonic Systems	Scrubber	182,000+	6,500+
Turbotak	Scrubber	54,850+	N/A

All proposals received re the above are on file. The Air Correction Multicyclone proposal in particular merits further investigation as the approach appears viable.

Allyn Todd

Allyn Todd

AT:mlm

c.c. - Mr. B. Kazmel

(supplied MECL baghouse)

PROPOSED BAGHOUSE SPECIFICATIONS

Unit Weight: 50,000 LBS.

Number of Modules: THREE (3) SIZE 165 HP 1215 TWH

Number of Bags: 3 × 165 = 495 TOTAL

Bag Material: WOVEN FIBERGLASS - 16 OZ/SQ.YD. WITH 7-10% TEFLON B.

Air Pressure required to blow: 90-100 PSIG

Air Volume required to blow: 30 SCFM

Gas Path ΔP through unit at rated capacity: 8" W.G - INLET-OUTLET

Footprint size: 12" SQ. BASEPLATE 9" SQ. BOLT CENTERS, (4) - 1" ϕ ANCHORBOLTS.

Overall Diminensions (H,W,D): 38'-0" H × 24'-0" W × 10'-0" D

Cage Material: CARBON STEEL - 11 GA

Wall Material: CARBON STEEL - 10 GA.

Predicted Efficiency: 0.01 GR/ACF AT OUTLET

Unit Cost: $118,500.00 (BUDGET)

Delivery Cost: $6,000.00 (ESTIMATED)

Delivery time from receipt of P.O.: 16-18 WKS.

FLÄKT CANADA

PROPOSED ~~BAGHOUSE~~ ESP SPECIFICATIONS

Unit Weight:

Number of Modules:

Number of Bags:

Bag Material:

Air Pressure required to blow:

Air Volume required to blow:

Gas Path ΔP through unit at rated capacity:

Footprint size:

Overall Diminensions (H,W,D): 6½ m x 3m x 4½ m

Cage Material:

Wall Material:

Predicted Efficiency:

Unit Cost: ≈$400,000 installed.

Delivery Cost:

Delivery time from receipt of P.O.:

MIKROPUL LTD.

PROPOSED BAGHOUSE SPECIFICATIONS

Unit Weight:	2,750 lbs.
Number of Modules:	One (1)
Number of Bags:	480
Bag Material:	Nomex
Air Pressure required to blow:	100 P.S.I.
Air Volume required to blow:	37.8 S.C.F.M.
Gas Path ΔP through unit at rated capacity:	6" W.G.
Footprint size:	
Overall Diminensions (H,W,D):	34'-0 3/4" x 10'-2" x 18'-
Cage Material:	1/8" C.S. Rod
Wall Material:	12 ga. C.S.
Predicted Efficiency:	99.99%
Unit Cost:	\$98,977.00
Delivery Cost: (Est.)	\$10,000.00
Delivery time from receipt of P.O.:	18-20 Weeks

AIR CORRECTION CANADA
(supplier of Chatham CWF baghouse)

PROPOSED BAGHOUSE SPECIFICATIONS (see also A.R. Correction Cyclone Collector alternative)

Unit Weight: Operating 20,000 Lbs.

Number of Modules: 1

Number of Bags: 410

Bag Material: Nomex (10 ft. length)

Air Pressure required to blow: 80 - 100 PSI

Air Volume required to blow: 50 SCFM Max.

Gas Path ΔP through unit at rated capacity: 6" W.G.

Footprint size:

Overall Diminensions (H,W,D): (19' - 8 1/2")x(7' - 6")x(24' - 4")+ cleara
Ht.

Cage Material: Mild Steel

Wall Material: Mild Steel

Predicted Efficiency: 95+ Percent

Unit Cost: Per attached proposal - 72,990

Delivery Cost: Not submitted.

Delivery time from receipt of P.O.: 12 - 16 weeks

AIR CORRECTION CANADA
(supplier of Chatham CWF Baghouse)

PROPOSED ~~BAGHOUSE~~ SPECIFICATIONS

Multicyclone Dust Collector

Unit Weight: 12,000 lb.

Number of Modules: 1

Number of ~~Bags:~~ Tubes: 100 x 6" ϕ

Bag Material: —

Air Pressure required to blow:

Air Volume ~~required to blow~~: capacity: 23,632 ACFM

Gas Path ΔP through unit at rated capacity: 3.25" w.G.

Footprint size:

Overall Diminensions (H,W,D): ≈20 ft. high + clearance beneath hopper
(20' x 7' x 7')

Cage Material:

Wall Material:

Predicted Efficiency: >95%

Unit Cost: $40,415.

Delivery Cost: Not submitted

Delivery time from receipt of P.O.:

HYDROSONIK SYSTEMS

PROPOSED ~~BAGHOUSE~~ SPECIFICATIONS
SCRUBBER

Unit Weight: 11000 lb.

Number of Modules:

Number of Bags:

Bag Material:

Air Pressure required to blow:

Air Volume required to blow:

Gas Path ΔP through unit at rated capacity: 27" W.G.

Footprint size:

Overall Diminensions (H,W,D): ≈35' x 45' x 8'

Cage Material: }
Wall Material: } S.S. and fiberglass reinforced plastic

Predicted Efficiency: 0.06 gr/dscf at unit outlet.
SO_2 Removal: 90%

Unit Cost: $140,000 U.S. (optional control pkg. + $15,260 U.S.)

Delivery Cost: $5,000 U.S.

Delivery time from receipt of P.O.: 16-18 wks.

NOTE: Wastewater effluent treatment system is extra, from Lancy International. No quotation available yet (87/09/21).

TURBOTAK INC. (based on quotation to Dave Burnett, 87/07/17).

PROPOSED ~~BAGHOUSE~~ SPECIFICATIONS
SCRUBBER

Unit Weight:

Number of Modules:

Number of Bags:

Bag Material:

Air Pressure required to blow:

Air Volume required to blow:

Gas Path ΔP through unit at rated capacity:

Footprint size:

Overall Diminensions (H,W,D): ≃ 10'x20'x5'

Cage Material: } 316 L S.S.
Wall Material: }

Predicted Efficiency:

Unit Cost: $54,850 (excluding controls)

Delivery Cost: not submitted

Delivery time from receipt of P.O.: 10 wks. from dwg. approval

Note: The system quoted on to Dave Burnett is undersized for the actual application due to use of gas volumes which are too low (by >twice). Thus actual unit cost will be greater than quoted.

Also, wastewater treatment system is not quoted on.

MINUTES OF MEETING #3

MINAS BASIN PULP AND POWER CWF CONVERSION STEERING COMMITTEE

November 18/87

submitted by

ALLYN TODD, P.ENG.

CAPE BRETON DEVELOPMENT CORPORATION

Location: Minas Basin Pulp and Power Co. Ltd. Boardroom
Hantsport, N.S.
Time: Wednesday, November 18, 1987 - 9:30 a.m.
Attendees: Peter Zwicker) Minas Basin Pulp & Power
Adrian White) CBDC
Bob Kazmel)
Allyn Todd)
Dave Lawrence) MBB
Ed Bain) NSDM&E
Phil Read) EMR
Kelly Thambimuthu) CANMET

Minutes

Minutes of the last steering committee (SC) meeting were read and the following points noted:

- Spelling of "Thambimuthu" corrected.
- A. White has written to OSF as per the minutes of the last SC meeting. No response yet.
- K. Thambimuthu to do experimental combustion work at CCRL in early December and will characterize the fly ash and utilize the existing ESP on the test rig.

New business proceeded with a discussion of budget expenditures. Over-expenditures to date are partially offset by savings in other areas. The end result is an overrun of $30,000 to $40,000 right now.

A new blowdown tank is required. Quotes on new and used are being solicited. By the end of the week the estimates will be in. (Expect the price range to be between $5,000 and $18,200.)

Concern was expressed over the condition of the boiler if the blowdown tank is shot. Must wait now for the hydrostatic boiler test after installation but before mods are completed to the boiler front.

The largest problem to date has been soil conditions. Jacques Whitford had to be called back in. Lack of solid base soil required piles to 74'9". Predictions by Jacques Whitford had been 25'. The average depth was 42 ft.

Any fears of the crane for lifting the boiler settling under a 35t lift were dispelled by the presence of a 25 ft. engineered fill base. No problem is anticipated.

The sump area under the deaerator will appear as an exta. Update meetings have been conducted on site to keep all site team personnel aware of progress and problems. Peter Zwicker is looking after arrangements for the new water softener.

The boilerhouse can be turned over to MBB Mechanical today. Concrete has had 2 weeks curing time. Overall, an 8 day loss in the schedule has occurred but this does not affect the start-up date as losses were absorbed by slack time.

The Oil Substitution Fund (OSF) SC were upset about the cost overruns. Lines struck during excavation were not mapped and predictable (re location) and re-designing of the foundation was necessary. There were no options available for a new site.

Copies of a summary of Project No. 2 Update are to be circulated by NSDME to the OSF-SC and are to include several photographs (5 copies of each will be required) of site preparation work. The summary will go to Brian Cook, Nancy Mitchell, John Laffin and Dan Brown. P. Read is to provide Lorne MacNeil with a copy of a previous communication to Nancy Mitchell which will assist Lorne with writing the summary. The next OSF-SC meeting is scheduled for January 20, 1988.

No response to A. White's letter to the OSF-SC is expected before the January 20th meetinq. This is a high priority item now and reasonable overruns will be given fair consideration. Reports by P. Read and Lorne MacNeil to Nancy Mitchell will say the funds have not been wasted and there should be no problem with getting the funds if the money is there. Approximately $30,000 to $60,000 is in the pot.

A Progress Payment report form (attached) was tabled by B. Kazmel. MBB will begin billing November 30. Lindsays' bill is in now for about $93,000.

MBB will be on site Monday, November 30 and on December 7 to place heavy items on foundations. After December 2 Lindsays can begin the building. They are scheduled to start December 7 and take about 1 week. The ID fan delivery date is December 14. On November 30 the boiler is to be on site and lifted into place.

A boiler location drawing was presented by MBB and copies distributed to attendees. A hopper and access door has been added to the air heater design to enable catch of heavy CWF fly ash particulate.

January 12, 1988 is still set for commissioning on oil. MBB agreed, with no foreseeable delays on their part. MBP&P shut down for Christmas (except for maintenance) December 24 to January 4. However, MBB plan to work over the holiday.

Limited MBP&P manpower resources (1 electrician and 1 electronics technician) were questioned re availability to the project. This could cause delays to the January 12 start-up date if they were not available when needed - their first responsibility is to keep the plant operating. If no problems in the plant develop, January 12 still holds. Problems with tie-in extensions will be discussed after a meeting with MBB.

The next meeting of the MBP&P Project SC will be before commissioning - January 6, 1988, 9:30 a.m., this boardroom. The building should be up and heavy equipment all in with water softener room and equipment installation nearly complete. The OSF-SC could do a site visit around January 20.

February is the earliest conceivable date for a ribbon cutting ceremony and announcement.

DOE have asked P. Zwicker what emissions are expected. Peter's response was that the system would be a clean burn and would include monitoring of stack emissions and compliance with DOE limits. DOE requested a description of the burner and combustion system. P. Zwicker will respond with description as attached.

There may be a requirement for a screw conveyor and dumpster to remove ash from the air heater hopper. Predictions of particulate emissions cannot be made with any accuracy due to unknowns in ash dropout at the air heater. SO_2 emissions will be about 1.5 lb./MM compared to >2lb./MMBtu on oil.

Discussion of the erection of a sign after a clean stack is confirmed was deferred until after commissioning.

CWF plant start-up is scheduled for early January. Additional staff have been employed and are now undergoing training.

Commissioning of the boiler on oil will be with a conventional atomizer first followed by commissioning of the NRC atomizer on oil and on CWF.

No problems are anticipated with fuel freezing. There is more concern at present over filtering the fuel properly to eliminate any flakes of dried fuel out of the tanks from reaching the burner.

The next project update will be issued November 30 and at the end of every subsequent month. An overall summary of project schedule to date is: we are from 7 to 9½ weeks from start date and can still maintain January 12, 1988 start-up. Subsequent project budget summaries should include "percent complete".

A burner/air register is to be obtained from MECL (if permission is granted by MECL-SC), brought to MBB shops and modified appropriately for MBP&P. There was no disagreement to this approach. However, the unit would be inspected closely to ensure all design changes required have been incorporated and that the unit looks new. MBB will approach the MECL-SC with this request. The reason given by MBB for this approach was time constraints of current MBB work load. No compromise in performance is anticipated. Shop fabrication of other components is proceeding on schedule with several items being sub-contracted.

It was decided that the Technical Sub-Committee (TSC) should meet to finalize plans for burner modifications, as soon as possible. Tentative date selected was November 26, 11 a.m. at MBB offices.

Town Council has given their blessing to the project and agreed to keep plans quiet with respect to public knowledge and media contact. All required building permits are in place.

P. Zwicker is to obtain a written permit from DOE for start-up. This is a demonstration project and we require time to commission and assess performance. The SC needs to know what will shut the project down (by DOE). P. Zwicker will request a permit but cannot predict performance until monitoring is done. Dave Gates, Provincial DOE representative, is MBP&P's contact. Inviting Dave Gates to a future SC meeting was discussed. Pros and cons both were expressed. It was generally felt that DOE was likely to be more understanding of the entire project if they see other government agencies involved. P. Zwicker is currently the contact and it should be kept that way. The solution agreed upon was to have Dave Gates meet with B. Kazmel, P.Zwicker and E. Bain on November 23 at E. Bain's office for an informal meeting. This will provide an opportunity for P. Zwicker to provide additional information and request the permit. E. Bain will arrange the meeting.

Action Items

1.	Summary of Project No. 2 update to be prepared for OSF-SC.	E. Bain
2.	P. Read to provide copy of communication with Nancy Mitchell to Lorne MacNeil	P. Read
3.	P. Zwicker to provide combustion system description to DOE	P. Zwicker
4.	MBB to request burner from MECL	D. Lawrence
5.	Technical Sub-Committee to meet Nov. 26	TSC
6.	P. Zwicker to obtain start-up permit from DOE	P. Zwicker
7.	E. Bain to arrange meeting with NSDME, CBDC, MBP&P and DOE	E. Bain

Submitted by Allyn Todd
Allyn Todd

AT:mlm

c.c. - Attendees
R. Nicholson
Joel MacLean

PROGRESS PAYMENT

MINAS BASIN PULP & POWER CO.LTD.
P.O. BOX. 401
HANSPORT, NOVA SCOTIA. B0P-1P0

PROJECT MINAS BASIN COAL WATER CONVERSION
CONTRACTOR M.B.B. MECHANICAL SERVICES LDT.
ADDRESS P.O.BOX.39, LAKE SIDE, N.S. B0J-1Z0
P.O. NO. ____

PAGE 1 OF 2
DATE ____
PROGRESS PMT. NO. ____
FROM ____ TO ____

ITEM NO.	UNIT NO.	DESCRIPTION	CONTRACT AMOUNT				THIS CLAIM		PREVIOUS CLAIMS		TOTAL TO DATE	
			UNIT	UNIT PRICE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE
1	22	STACK REMOVAL			100%	6025						
2	23	STACK TRANSPORT			100%	880						
3	24	STACK INSTALLATION			100%	8200						
4	25	BOILER REMOVAL			100%	29125						
5	26	BOILER TRANSPORT			100%	6630						
6	27	BOILER INSTALLATION			100%	45708						
7	28	MECHANICAL MATERIALS			100%	20160						
8	29	MECHANICAL INSTALLATION			100%	34226						
9	32	P & I ENGINEERING			100%	1128						
10	33	VIEW PORT ENLARGEMENT/BACKWALL			100%	500						
11	42	CWF PIPING MATERIALS			100%	3130						
12	43	CWF PIPING INSTALLATION			100%	7930						

PREPARED BY:
CONTRACTOR ____ DATE ____
RECOMMENDED FOR PAYMENT ____
PROJECT CONSTRUCTION MANAGER ____ DATE ____

EXTENSIONS CHECKED
PROJECT ADMINISTRATOR ____ DATE ____
APPROVED FOR PAYMENT ____
PROJECT MANAGER ____ DATE ____

ORIGINAL CONTRACT VALUE 441891
APPROVED C.C.A'S ____
CURRENT CONTRACT VALUE ____
"AS OF" DATE ____
* NOT APPLICABLE TO FIXED PRICE CONTRACTS

WORK TO DATE VALUE ____
LESS HOLDBACK 10% ____
BALANCE ____
PREVIOUSLY CLAIMED ____
AMOUNT THIS CLAIM ____

PROGRESS PAYMENT

MINAS BASIN PULP & POWER CO.LTD.
P.O. BOX. 401
HANSPORT, NOVA SCOTIA. B0P–1P0

PROJECT MINAS BASIN COAL WATER CONVERSION
CONTRACTOR M.B.B. MECHANICAL SERVICES LDT.
ADDRESS P.O.BOX.39, LAKE SIDE, N.S. B0J–1Z0
P.O. NO.

PAGE 2 OF 2
DATE
PROGRESS PMT. NO.
FROM TO

ITEM NO.	UNIT NO.	DESCRIPTION	CONTRACT AMOUNT				THIS CLAIM		PREVIOUS CLAIMS		TOTAL TO DATE	
			UNIT	UNIT PRICE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE	QUANTITY % COMP.	VALUE
13	53	CWF BURNER FABRICATION/DELIVERY			100%	13988						
14	54	BURNER INST. STRUCTURAL MODS.			100%	13284						
15	55	BURNER INST. REFRACTORY MODS.			100%	18181						
16	56	BURNER INSTALLATION			100%	1080						
17	57	CWF IGNITOR			100%	2750						
18	58	BALANCE DRAFT DESIGN			100%	10080						
19	59	BALANCE DRAFT DUCTWORK			100%	47000						
20	60	BALANCE DRAFT INSTALLATION/DELIVERY			100%	64917						
21	61	AIR HEATER			100%	82482						
22	62	ID. FAN			100%	37800						
23	63	STEAM COIL AIR HEATER			100%	12018						
24	64	VIEW PORT/BURNER END			100%	900						
25	90	BONDING,PERMITS,CERTIFICATES			100%	3134						

PREPARED BY:
CONTRACTOR ...... DATE
RECOMMENDED FOR PAYMENT
PROJECT CONSTRUCTION MANAGER ...... DATE

EXTENSIONS CHECKED
PROJECT ADMINISTRATOR ...... DATE
APPROVED FOR PAYMENT
PROJECT MANAGER ...... DATE

ORIGINAL CONTRACT VALUE 441891
APPROVED C.C.A'S
CURRENT CONTRACT VALUE
"AS OF" DATE
* NOT APPLICABLE TO FIXED PRICE CONTRACTS

WORK TO DATE VALUE
LESS HOLDBACK 10%
BALANCE
PREVIOUSLY CLAIMED
AMOUNT THIS CLAIM

DESCRIPTION OF THE CANMET/NRC BURNER AND ATOMIZER FOR THE PACKAGE BOILER INSTALLATION AT THE MINAS BASIN PULP AND POWER COMPANY, HANSPORT, NOVA SCOTIA

1. BACKGROUND

The Canada Center for Mineral and Energy Technology (CANMET) burner register and the National Research Council (NRC) two-fluid fuel atomizer for coal-water fuel (CWF) and heavy fuel oil (HFO) combustion, was developed as part of the R & D initiatives on CWF technology undertaken by Energy Mines and Resources (EMR) Canada. Funding and technical expertise for this specific development was provided by the Canada Center for Mineral and Energy Technology (CANMET), a R & D division within EMR. The National Research Council (NRC) was subcontracted by CANMET to build the atomizer component of this burner system.

At the present time the burner may be classified as an operational prototype. The developmental work undertaken since 1984 has been based on flame scaling trials at 6 million Btu/h, 40 million Btu/h, and a 55 million Btu/h firing rates. The present prototype to be installed in the Minas Basin Pulp & Power Company's (MBP & P) coal-water fuel fired package boiler has been tested at a nominal 55 million Btu/h scale, with an upper limit of 70 million Btu/h and a lower limit of 33 million Btu/h, representing a 2:1 turn down ratio on CWF. A corresponding turn down ratio of 8:1 was also demonstrated on HFO. These trials were undertaken in Unit No. 10, an oil-designed utility boiler at the Maritime Electric Company's Charlottetown Generating Plant. Proving trials, and the commercialization of this prototype version rated at a nominal 55 million Btu/h for industrial and utility boiler applications, is dependent on the outcome of the present demonstration program in the MBP & P package steam boiler, and a 5 burner test program to be completed in summer 1988 at the Charlottetown generating plant. These applications, beside demonstrating burner performance, will also provide boiler performance, environmental emission data, and long term capital and operating costs assessments for the conversion from HFO to CWF.

2. TECHNICAL DESCRIPTION

A. BURNER REGISTER AND QUARL

The burner register comprises of two parts; a mechanical assembly of swirl vanes, flow separation ducts and control dampers, and a refractory quarl. The mechanical assembly, which is fabricated as an integral unit provides a means for optimizing air-fuel mixing to create a defined flame envelope in the boiler. The quarl which is cast from refractory in the boiler front wall, serves as an outlet for the combustion air flow from the register. The burner register and quarl design combination, play a critical role in acheiving the desired air flow and fuel spray mixing patterns necessary to sustain stable ignition and burnout of the fuel within the boiler chamber.

A schematic diagram of the CANMET burner register/quarl design, and the resulting flow mixing pattern is shown in figure 1. The burner register is configured to generate concentric primary and secondary swirling combustion air jets, with independent control of the swirl level and mass flow in the respective air streams. The latter feature provides a method to sustain stable coal-water fuel and oil flames, employing an identical register configuration with fuels which differ significantly in their chemical

DESCRIPTION OF THE CANMET/NRC BURNER AND ATOMIZER FOR THE PACKAGE BOILER INSTALLATION AT THE MINAS BASIN PULP AND POWER COMPANY, HANSPORT, NOVA SCOTIA

reactivity. This dual fuel firing capability is generally obtained by adjusting the relative swirl/mass flow rates between the primary and secondary streams, to reduce flow mixing and heat dilution in the recirculation zone when firing the less reactive CWF. With the introduction of the combustion air flow in staged primary and secondary streams in the burner, and due to the high moisture content in the the fuel which lowers the CWF flame temperature, NO_x generation in the flame is reduced by approximately 30% relative to conventional pulverized coal fired burners. A simultaneous reduction in the sulphur emission when burning CWF is also obtained because sulphur bearing pyrites are liberated and removed as part of the CWF production process.

B. FUEL ATOMIZER

Figure 2 shows a schematic illustration of the NRC dual fuel (CWF/HFO) two-fluid atomizer. The atomizer is a pre-filming nozzle with an outer liquid fuel sheet which is broken up by an inner concentric atomizing steam flow. The atomizer contains a conical ceramic tip and matching ring, and the angle of the cone and ring assembly determines the angle of the fuel spray. The spray angle is an adjustable parameter, and is often selected in field trials to generate the most compact and stable flames. Depending on the furnace configuration, the optimum spray angles may also differ for CWF and HFO combustion.

The atomizer discharge area is adjustable, and is controlled by an external micrometer with low and high gap settings on a graduated scale. This adjustable feature permits fine tuning of the nozzle to maintain throughput, high outlet discharge velocities, and a spray quality independent of the variable shear dependent rheology of CWFs. The same adjustable feature also permits a convenient means of fuel switching to HFO by closing down the discharge gap. This reduction is necessary due to large differences in the viscosity of HFO and CWF, which would otherwise cause a higher oil throughput to the burner during fuel switching. The ceramic cone and ring assembly in the atomizer is abrasion resistant, and prevents wear of critical nozzle components. This feature also maintains the spray quality, the deterioration of which will rapidly destabilize a CWF flame.

Dr. K.V. Thambimuthu,
Research Scientist,
Energy Research Laboratories,
CANMET,
Energy Mines and Resources,
Ottawa.

6th November 1987

c.c. Cape Breton Development Corporation, Sydney, NS.

Nova Scotia Department of Mines and Energy, Halifax, NS.

Minas Basin Pulp and Power Co., Hansport, NS.

DESCRIPTION OF THE CANMET/NRC BURNER AND ATOMIZER FOR THE PACKAGE BOILER INSTALLATION AT THE MINAS BASIN PULP AND POWER COMPANY, HANSPORT, NOVA SCOTIA

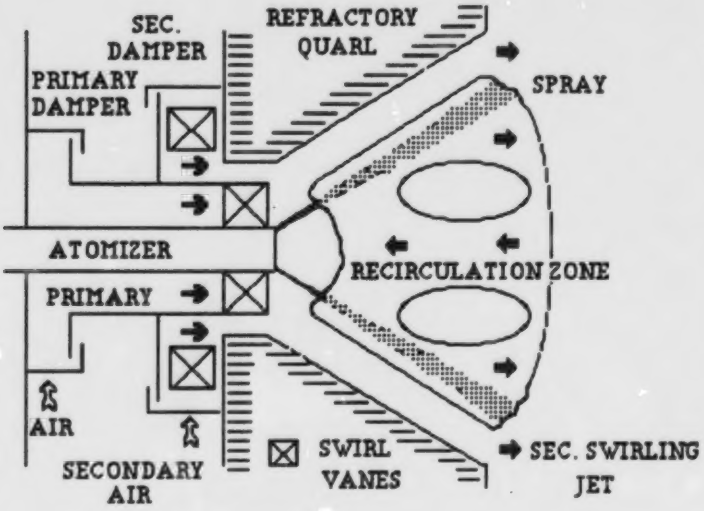

SEC.
DAMPER
REFRACTORY
QUARL
PRIMARY
DAMPER
SPRAY
ATOMIZER
RECIRCULATION ZONE
PRIMARY
AIR
SECONDARY
AIR
SWIRL
VANES
SEC. SWIRLING
JET

FIGURE 1. CANMET BURNER REGISTER, QUARL AND FLOW PATTERNS.

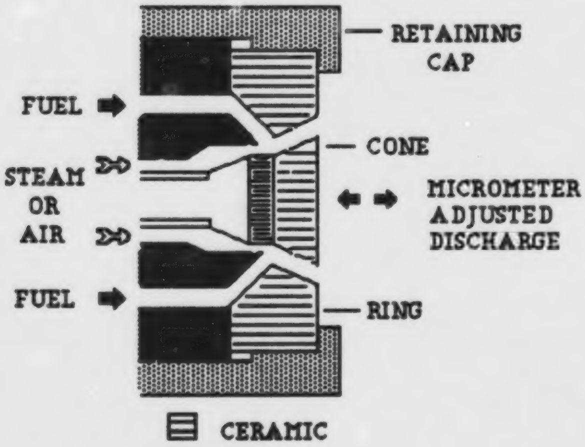

RETAINING
CAP
FUEL
CONE
STEAM
OR
AIR
MICROMETER
ADJUSTED
DISCHARGE
FUEL
RING
CERAMIC

FIGURE 2. SCHEMATIC DIAGRAM OF THE NRC DUAL FUEL ATOMIZER

CARBOFUEL - MINAS BASIN PROJECT MINUTES

Steering Committee Meeting No. 4
Minas Basin Pulp & Power Company Ltd.
Hantsport, Nova Scotia
January 6, 1988

Attendees:

Ed Bain, N.S. Dept of Mines & Energy, Chairman
Phil Read, Energy Mines & Resources, Canada
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Kelly Thambimuthu, CANMET
Joel MacLean, Cape Breton Development Corporation
Allyn Todd, Cape Breton Development Corporation
Lorne MacNeil, N.S. Dept of Mines & Energy
Adrian White, Cape Breton Development Corporation
Bob Kazmel, Cape Breton Development Corporation

1. Minutes from the Last Meeting

The minutes from the last meeting were reviewed. Mr. Bob Kezmel will provide slides to Lorne MacNeil for a presentation to the Oil Substitution and Conservation Agreement Management Committee. This will replace the Project Summary noted in Action Item 1. The remaining items are complete.

2. Review of the Work and Expenditures to Date

Mr. Kazmel reported that approximately $87,000 in cost overruns have been incurred to date. However, cost savings in other areas will bring the current overrun down to about $22,000. With other extra costs anticipated, it is estimated that the total overrun at the end of the project will be approximately $70,000.

A number of items have caused schedule delays. The water softener, which should have been installed by now, will not be on site for another 10 days.

Because of changes in the code, the blowdown tank is too small and a new one must be built. Bids ranging from $10,000 to $18,000 have been received from three manufacturers. The lowest bidder does not have an ASME U stamp, so they will be checking with the next highest bidder.

Poor weather has contributed to further delays. It also appears MBB have too much work at the present time. Their men were pulled from the site for two weeks over the Christmas holidays. Their men have also been hampered by lack of drawings. After pressuring them, MBB have called in Fenco-Shawinigan for some of the civil and mechanical work.

Dr. Kelly Thambimuthu reported that he met with MBB in September and November to arrange for them to prepare some drawings. He has still not received these. A copy of the letter Mr. Thambimuthu circulated is attached to these minutes.

. . . 2/

Mr. Adrian White indicated that CBDC was disappointed with MBB's ability to meet Project Schedules. A general note of concern was aired by the Committee as far as giving any future CWF contracts to MBB.

The Committee discussed ways of forcing a faster response from MBB. It was agreed that Mr. Bain should write to Mr. Dave Burnett and ask him to attend a meeting on the afternoon of the next Technical Steering Committee meeting. This will give members an opportunity to discuss their problems with MBB's performance to date.

3. Discussion of the Next Phase

Mr. Kazmel reported that the boiler house would be complete with one more day of good weather. Work on the oil set is nearly complete. Drawings were expected tomorrow for the CWF piping. All piping (except for the blowdown line) should be finished in four weeks. The blowdown tank will not be ready for at least seven weeks, so a temporary line may have to be run to sewer if an earlier start-up is required. They will be carrying out a quick hydro-test to confirm the integrity of the boiler. If nothing shows up on this test, the boilmakers' work will be through in two weeks.

Overall the project is four to eight weeks behind schedule. The earliest date possible for starting up the boiler will be in the latter half of February. Dr. Thambimuthu noted that it would be helpful to have the boiler commissioned before March 31, 1988, so that CANMET can pay the first half of their commitment in this fiscal year. Mr. White indicated that they hope to bill both CANMET and the Oil Substitution Agreement Management Committee before that date.

4. Technical Advisory Committee

Mr. Allyn Todd reported that the Technical Advisory Committee had met in November to discuss modifications to the CANMET burner. The next meeting of this committee is scheduled for January 15, 1988, to discuss burner management controls. Lorne MacNeil requested that he be supplied with minutes of these meetings.

5. Meeting with Department of the Environment

Mr. Peter Zwicker reported on a meeting which was held with Mr. David Gates of the Department of the Environment. Mr. Gates has been informed that stack emissions will be monitored after start-up and any environmental standards will be met. Another meetings is scheduled with Mr. Gates this afternoon.

6. Other

Mr. Kazmel informed the Committee that Jacques-Whitford and Associates would be preparing a report explaining why the piles had to be driven deeper than expected. Lorne MacNeil requested he be sent a copy of this report.

The next Technical Steering Committee meeting is scheduled for 9:30 a.m., February 17, 1988 at the Minas Basin site. The meeting will be rescheduled to February 23 if Mr. Dave Burnett is unavailable for the afternoon of the 17th.

Attachment

CARBOFUEL - MINAS BASIN PROJECT MINUTES

Steering Committee Meeting No. 5
February 25, 1988

Attendees:

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Bob Kazmel, Cape Breton Development Corporation
Kelly Thambimuthu, CANMET
Adrian White, Cape Breton Development Corporation
Phil Read, Energy, Mines & Resources, Canada
Lorne MacNeil, Nova Scotia Department of Mines and Energy
Allyn Todd, Cape Breton Development Corporation

1. Minutes from the Last Meeting

The Steering Committee reviewed the minutes of the last meeting and recommended the following changes:

Section 2

Paragraph 4, line 2 should read:

"Their men were pulled from the site for two weeks over the Christmas holidays."

Paragraph 5 shall have the following line added:

"A copy of the letter Dr. Thambimuthu circulated is attached to these minutes."

Paragraph 6 should read:

"Mr. Adrian White indicated that CBDC was disappointed with MBB's ability to meet Project Schedules. A general note of concern was aired by the Committee as far as giving any future CWF contracts to MBB."

2. Review of Work to Date

Mr. Bob Kazmel reported on work which has taken place since Project Report #5 was issued (January 30, 1988).

Electric trays are now in, and instrumentation wires have been run. Work has started on the terminal box hook-ups. The Operator Interface Unit (OIU) is on site and has been tested. The computer which will be used for logging and report generation is also on site.

Work in the Water Treatment area is 90% complete. Some tie-in must still be completed.

The boiler passed the hydro test yesterday. Some repairs will have to be carried out on the deaerator tank tray. X-raying will be carried out on the welds of the deaerator heads. Magnetic particle inspection will also be carried on the welds from inside the tank.

Insulation work is almost complete. Insulators are currently working on the ID fan. A new TEFC motor has been received and is to be installed on the ID fan.

The two fuel tanks are being cleaned up. One is in good shape; the second is showing some rust.

The burner work is almost done. Two NRC atomizers are ready to be shipped from Ottawa. Two standard Y-jet heavy fuel oil (HFO) atomizers are on site. One is rated at 80 million Btu/hr; the second is rated at 30 million Btu/hr.

The current plan is to spend week one commissioning with HFO and a standard Y-jet atomizer, week two commissioning with HFO using an NRC atomizer, and week three commissioning with coal-water-fuel (CWF) using an NRC burner. It may also be necessary to get a lower capacity NRC burner (for say 30,000 lb/hr) to allow CWF to be used in the summer when loads are reduced.

At present there are two dampers to be adjusted to give maximum efficiency for either HFO or CWF. It may be necessary to lock these in place. If so they will be set for maximum CWF efficiency. Hopefully this will still give an acceptable efficiency when HFO is used.

The installation of the steam header has been awarded to a local contractor at a price of approximately $27,000. The blowdown tank should be ready either tomorrow or Monday.

It is now planned to start up on oil on March 7, 1988 and on CWF on March 21, 1988.

3. Environmental Issues

Mr. Peter Zwicker reported that a letter has been sent to Mr. David Gates to outline the action to be taken to ensure the environmental acceptability of the stack emissions. A copy of this letter is attached. It is expected that burning CWF will produce lower sulfur oxide emissions than HFO, but particulate levels will be higher. Mr. Adrian White suggested that particulate emissions may be no higher than those released during wood burning.

Mr. Ed Bain questioned how we will determine whether emission controls are required. Mr. White responded that after the unit is lined out, all stacks on site will be sampled. The specific requirements that will have to be met are not yet known. Dr. Read suggested a concrete plan should be in place in the event there are problems. Dr. Thambimuthu informed the Committee that discussions have been held with Mr. Neil Stover at the Nova Scotia Research Foundation to conduct a program to characterize the ash and to develop a cyclone to remove it. Mr. White stated that if the problems were so severe that the Department of Environment can't be satisfied, Minas Basin Pulp and Power will be allowed to use oil until a suitable method of stack cleaning is found.

Dr. Read asked whether any consideration has been given to removal of bottom ash. Mr. Kazmel replied that tile ~~has been~~ is sloped to the ~~front.~~ side The boiler will be opened up after one weeks operation on CWF. If substantial ash has built up, it may be necessary to install some means of removing ash more easily.

4. **Expenditures**

As of January 30, 1988, the cost overruns totalled $117,432.53. With savings achieved in other areas, the net overrun at that date was $70,623.

Mr. Bob Kazmel reported that he intends to have bills for CANMET and the Oil Substitution and Conservation Agreement sent out before the end of the month. He also hopes to send a letter to Lorne MacNeil by April 6, 1988 to request additional funding to cover the overruns.

5. **Press Release**

Mr. Ed Bain presented a draft press release which he had prepared to announce this project. Copies have also been sent to Energy, Mines and Resources, Canada for comment. The Committee recommended a number of minor changes.

Dr. Thambimuthu requested that he be sent a copy of the revised press release.

6. **Afternoon Meeting with Mr. Dave Burnett**

The Committee discussed various concerns about the project which will be reviewed with Mr. Burnett this afternoon. A copy of the minutes of that meeting shall be appended to these minutes.

7. **Other**

The Committee discussed the possibility of installing a sign on the boiler house. The Oil Substitution and Conservation Agreement Management Committee plan to visit this site at the time of their next meeting; the matter of a sign will be discussed at that time.

The next meeting will be held at Hantsport on April 5, 1988 at 1:30 p.m.

COPY

MINAS BASIN PULP & POWER COMPANY LIMITED

February 5, 1983

Mr. D. Gates,
Nova Scotia Department of the Environment,
P. O. Box 2107,
Halifax, N. S.
B3J 3B7

Dear Mr. Gates:

Re: Environmental Emissions Evaluation at MBPP

In response to your request made at our 1988-01-06 meeting in Hantsport for additional information concerning the CWF demonstration, I am forwarding a brief outline of our plan to determine the best approach to obtain satisfactory stack emissions.

As you are aware, the Minas Basin Pulp & Power Company is being assisted by the Cape Breton Development Corporation in the planning and cost estimation phase of a demonstration project to install a process steam boiler (60,000 lb./hr. steam) fired with coal-water fuel. An essential element of the project is the determination of emissions from the new boiler in order to evaluate the requirements for flue gas cleaning equipment. As discussed at our 1988-01-06 meeting, past CWF tests at Chatham and Charlottetown employed inferior combustion equipment resulting in poor carbon conversion and high particulate levels in the stack. A bag house was used at Charlottetown to minimize stack emissions but this was a troublesome area of operation during the project. Improved combustion performance for this project and our efforts to avoid the extensive operational problems of a baghouse have necessitated looking for a more cost effective way to minimize potential stack emissions while burning CWF.

As a first step, our system design will include a 3-pass tubular combustion air preheater configured in such a manner as to induce the dropout of particular matter into an ash collection hopper from which the catch can be removed to disposal. In addition, the rate and characterization of particulate emissions will be accurately estimated after the

COPY

system is operational. To effectively determine the hopper performance, a stack testing program will be implemented immediately after commissioning the boiler on coal-water fuel. The results obtained will be used to assess the requirements for flue gas cleanup in order that the boiler may operate within the emissions guidelines recommended by the Provincial Department of the Environment. As discussed with you, selection of the most effective particulate emission control equipment is not possible until the ash from the CWF boiler is characterized using the improved burning equipment.

Since May of 1987, the project has obtained budget estimates from three organizations invited to submit stack testing proposals for our CWF conversion project. Each invitation clearly stated that any testing methodology proposed would comply with regulatory authority standards.

The following is the specification of the CWF that will be used for the demonstration.

MBPP CWF Specification

Moisture Content	30%
Ash (as received)	2.0% - 3.5%
Sulfur (as received)	1.0% - 1.5%
Heating Value (as received)	10,500 Btu/lb.
Volatile Matter	25%

If you have any further questions, please don't hesitate to call.

Yours truly,

Peter Zwicker, P. Eng.

PZ/ms

Nova Scotia

Department of Mines and Energy

PO Box 1087, Halifax, Nova Scotia B3J 2X1

News Release

Halifax, Nova Scotia

Minas Basin Pulp and Power Company, of Hantsport, will participate in a demonstration project using coal water fuel (CWF) to produce process steam, Mines and Energy Minister Ken Streatch announced today in the Nova Scotia Legislature.

The $1 million project is funded by the Canada-Nova Scotia Oil Substitution Fund; Energy, Mines and Resources' Canmet Labs; Cape Breton Development Corporation (C.B.D.C.), and Minas Basin Pulp and Power Company.

Coal water fuel (CWF) is a mixture of finely ground coal, water, and a stabilizer, which looks, stores and flows like oil. It was developed by C.B.D.C. at a pilot plant in Cape Breton and is being promoted as a substitute for oil.

The plant has recently been expanded to produce up to 50,000 tonnes of CWF per year. The Minas Basin project will use about 18,000 tonnes per year, which will replace up to 65,000 barrels of No. 6 oil annually.

Mr. Streatch said it was the first time in Canada that the coal water fuel has been used on a commercial basis to produce process steam in an industrial setting.

The Minister applauded the foresight of the Minas Basin Pulp and Power Company for taking the steps to augment its energy requirements by using a fuel indigenous to the province.

A feature of the fuel is that it contains less sulfur than the oil which it is displacing resulting in lower sulphur emissions, he added.

Cape Breton Development Corporation led the way in North America in the development of a clean burning coal based liquid fuel. C.B.D.C.'s research was assisted by financial support for demonstration projects under Energy, Mines and Resources Canada's Coal Utilization Program.

"A successful demonstration of this technology will attract customer attention and lead to commercial scale production of CWF by C.B.D.C.," Mr. Streatch said.

- 30 -

For further information contact:

Harry Chapman
N.S. Dept. of Mines and Energy
(902) 424-6745

Nancy Mitchell
Coal Division
Energy, Mines and Resources Canada
(613) 992-2018

March 2, 1988

CARBOFUEL - MINAS BASIN PROJECT MINUTES

Steering Committee/Contractor Meeting
Minas Basin Pulp and Power Company Ltd.
Hantsport, Nova Scotia
February 25,1988 - 1:30 p.m.

Attendees:

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Bob Kazmel, Cape Breton Development Corporation
Kelly Thambimuthu, CANMET
Adrian White, Cape Breton Development Corporation
Lorne MacNeil, Nova Scotia Department of Mines and Energy
Dave Burnett, MBB Mechanical Services Ltd.

This meeting was held to discuss with the contractor, MBB Mechanical Services, a number of aspects of the Minas Basin-Carbofuel Conversion Project which had raised the concern of the Technical Steering Committee. An informal list of topics was prepared and these were discussed in order.

1. Delays in Burner Drawings

Dr. Kelly Thambimuthu noted that he had experienced considerable difficulty in getting drawings of the Charlottetown burner modified to suit Minas Basin. Three meetings with NRC had to be cancelled as a result.

Mr. Dave Burnett noted that they had expected the drawings would be a straight trace. However, the drawings had to be modified based on Maritime Electric Co. Ltd. (MECL) experience.

Mr. Bob Kazmel pointed out that it was expected that changes would be incorporated. It was agreed that 20 different items had to be changed. The work was done first and then the drawings were made.

Mr. Burnett commented that the MECL drawings had cost $3,000 each and the Minas Basin drawings cost even more. They 'lost their shirts' on these drawings.

Mr. Kazmel agreed there had been a lot of revisions and more than expected.

2. Proprietary Issue (Licensing)

Dr. Thambimuthu spoke on the proprietary aspects of the burner design. MBB is currently manufacturing the burners under contract and secrecy agreement. CANMET owns the technology, but they want someone who can take it and run with it. If MBB is interested, they should contact Rabi Philar at CANMET (613-992-0340) as soon as possible to discuss licensing.

Ravi

Mr. Burnett stated that they were interested, but they would have trouble with some aspects, such as the air register, because they had the technology before hand.

Dr. Thambimuthu noted that all registers are similar. To obtain a patent requires unique features which they feel they have. If MBB has a problem with this, they should raise it with CANMET.

3. Delays in Approved Drawings/Materials

Mr. Kazmel felt the job was often delayed due to lack of drawings. The pipefitters especially were frequently working without approved drawings and, in fact, there are still no approved drawings.

Mr. Burnett noted that some isometrics had been prepared in November and December. These were reviewed on January 5, 1988. In some cases there was no intention to provide detailed piping drawings because the pipefitters run the lines where they want to anyway.

Mr. Kazmel responded that given the lead time from when the contract was signed (August), there was ample opportunity to prepare and review the drawings. However, MBB always seemed to have other priorities. It also appeared that David Lawrence didn't put the time in on this job that it required.

Mr. Kazmel also spoke of the delays in receiving materials. The pipefitter foreman planned for three days in advance and phoned in the order. Frequently material was missing. Some was supplied from CBDC, Minas Basin or CKF inventory and this has been replaced. With more planning for materials, this would not have been necessary.

Mr. Adrian White commented that the continual lack of drawings and materials gives the impression that MBB either doesn't care or is incompetent.

Mr. Burnett pointed out that much of the material could not be obtained "off the shelf" and they had to wait for delivery. MBB is a small company and they only have two draftsmen on staff. Their work time must be allocated according to priorities. This job did suffer as a result.

Dr. Thambimuthu commented, and Mr. Kazmel agreed, that the standard of work was good. However CANMET is very anxious to have someone pick up this technology and run with it. It is important to have someone who can meet schedules and do a good job. They must be prepared to make a commitment.

Mr. White noted that MBB did not have pipefitters on site when they were expected. In an emergency this is understandable, but we shouldn't have found out about it because people didn't show up.

Mr. Burnett explained that they didn't want pipefitters on site until the building was up. Mr. Kazmel felt that with a little more planning, things could have been done at that time which would have made the job go better for everyone. The main point is that there was good quality work, but the lack of drawings and materials caused a six to eight week delay.

4. Supervision

Mr. Kazmel noted that when problems arose, the pipefitter foreman always came to him to resolve them. While Mr. Kazmel was there to assist with problems, MBB should have had someone on site who was more in tune with what was going on.

5. Christmas Holidays

Mr. Kazmel reported that MBB personnel did not work over the Christmas holidays to meet the January 12, 1988 schedule. Mr. Burnett explained that experience has shown them that ordinarily half of the crew will not show up for half of the time over the holidays. MBB had never produced a bar chart saying they would be finished on January 12th.

Mr. Kazmel responded that it had been agreed that work would be carried out over Christmas. He only found out that people would not be there through rumors. Also the MBB estimate was for nine weeks to completion from award of the contract. There was a three week delay caused by site preparations and we still weren't ready.

Mr. Burnett emphasized that they can and must meet schedules for the pulp and paper industry. This is their bread and butter. There are still things outside of their control. This was not a typical situation. They are most interested in continuing to work with coal water fuels.

6. Comments by Mr. Andy Madden

Mr. Kazmel stated that in conversations Mr. Gordon Breton had with MBB's President, Mr. Andy Madden, derogatory comments were made about Mr. David Lawrence and about coal water fuels. If these sorts of comments are being made elsewhere, they will be very detrimental to efforts to market coal water fuels. This does not present good public relations for either MBB or CBDC.

Mr. Burnett responded that Mr. Madden is not involved in coal water fuels and is not given to making such comments in public. He is certainly out of line with the thinking of MBB on CWF. This work is important to MBB. Mr. Madden will be asked not to repeat such comments in public.

Mr. Kazmel asked why Mr. Lawrence's capabilities were brought into question. Mr. Burnett responded that Mr. Madden's experience is in field construction. He has a negative attitude toward all engineering departments. He is ordinarily more diplomatic.

Mr. White noted that he was being given a better impression of MBB's intentions toward CWF through this meeting. Mr. Burnett stated that MBB has promoted the use of CWF and they feel interest is growing. Its just a question of time.

Dr. Thambimuthu emphasized that we must have willing partners if CWF is to be properly promoted.

7. Off-loading and Laydown Area

Mr. Kazmel stated that the contractor was to have a supply trailer on site and a lay down area. Mr. Peter Zwicker commented that Minas Basin Pulp and Power had to look after the receiving and offloading. Items had to be moved several times.

Mr. Burnett noted that they had a tool crib on site. Ordinarily they would have dropped materials outside the boiler for convenience and covered them with a tarp. In this case there was very little free space and some of the electronic equipment couldn't be stored outside.

8. Fenco Work vs. Original Package

Mr. Kazmel indicated this problem had already been discussed with Mr. Burnett. Some of the steam header design which was contracted to Fenco should have been part of the original work package.

Mr. Burnett felt two items had contributed to this problem:

(1) some MBB personnel were not aware of what work was included in the original package

(2) stress analysis had to be carried out on the whole line which wouldn't have had to be done had we stuck to the original concept.

Mr. Zwicker commented that part of this was initiated by Fenco because of the route they picked. Mr. Kazmel also noted that it took a long time to resolve this issue.

9. Steam Header and Blowdown Tank Quotes

Mr. Kazmel stated that MBB's quotes for "extras" (the blowdown tank and the steam header extension) were much higher than they should have been. The steam header extension was originally quoted at $58,000 and revised to $48,000. The contractor who received the job quoted $27,000.

Mr. Burnett noted that their estimating capabilities have not been good outside the boiler area. He questioned whether the shop doing the work is union or non-union. Mr. Zwicker replied that they were charging the union rate ($35/hr), so it doesn't matter.

Mr. Kazmel also spoke on the confusion which occurred in ordering a new blowdown tank MBB's quote was for $18,200 and the low bidder, Sydney Engineering, quoted $10,300. Because MBB gave the impression an ASME U stamp was required for this job, the work was withdrawn from Sydney Engineering and given to Woodside Fabricators at a cost of $12,700.

Mr. Burnett commented that you have to assure yourself that equipment meets standards and an ASME U stamp is one way of doing this. Besides the code may be changed in the next 6 months to require this. It is required in other provinces.

Mr. Kazmel pointed out that we could have had a blowdown tank on site now for $2,400 less than it will cost now. We are getting the first ASME U stamp blowdown tank in the Province.

10. Overall Concerns

Mr. White questioned whether Mr. Burnett had any comments or complaints.

Mr. Burnett responded that the experience was generally good but sometimes there were delays in transmitting information. There were also some obvious miss fits in some of the valves that CBDC supplied.

Mr. Kazmel agreed that some confusion had resulted from supplying valves. On future jobs they may supply controls but they will never get involved in ordering valves again.

Dr. Thambimuthu reiterated his concern that Mr. Burnett should treat the burner technology as proprietary CANMET information. If MBB is interested in being involved they should approach CANMET as soon as possible to discuss licensing.

Mr. Burnett stated that the prospects were likely to be slim for a number of years. They are very interested in pursuing this issue, but they have limited resources. The front end costs for licensing are too much for a small company to accept, based on the current demand.

Dr. Thambimuthu felt this would not be a problem. There need not be up front costs; payments can be linked to sales. The important thing is how CANMET is approached. You must prove willing to promote it and take risks.

Carbofuel - Minas Basin Project Minutes

Steering Committee Meeting No.6
April 7, 1988

ATTENDEES:

Ed Bain, N.S. Dept of Mines & Energy, Chairman
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Kelly Thambimuthu, CANMET
Adrian White, Cape Breton Development Corporation
Allyn Todd, Cape Breton Development Corporation
Phil Read, Energy Mines & Resources, Canada
Lorne MacNeil, N.S. Dept of Mines & Energy

1. Minutes of the Last Meeting

The Committee reviewed the minutes of the last meeting and noted a number of minor corrections to be made. The Committee also requested that a copy of the minutes of the afternoon meeting on February 25, 1988 be sent to Mr. Dave Burnett.

2. Current Status

Mr. Peter Zwicker informed the Committee that most of the equipment was now installed and much of the insulation is complete. Some deficiences, such as leaks, a bad check valve and an unsuitable control valve, have already been identified and are being corrected.

Mr. Allyn Todd reported that steam was first raised on March 30, 1988 using the auxillary (oil-fired) atomizer. A poor flame from this atomizer may have resulted from the gun being off centered or because of too wide a gap in the atomizer which produced insufficient pressure drop. There has also been a problem with welding slage or pipe threads in the lines being pushed through the lines and getting caught in the atomizer tips.

Dr. Kelly Thambimuthu commented that a regulator on the propane line also malfunctioned because of a pipe thread on the seat. The coal water fuel (CWF) lines will be flushed now to avoid problems during commissioning.

Other areas which require work include refractory shrinkage, flame scanners, turndown ratio, balanced draft fans and CWF unloading. The new refractory around the air register has pulled away from the existing refractory and will have to be repaired. The flame scanners did not read properly at first but this appears to have been because they were not sighted in correctly.

The turn down ratio required has not been established as yet. The demand at Minas Basin varies from about 45,000 lb. of steam/hr. in the winter to about 25,000 lb./hr. in the summer. However the wood boilers will also produce about 10,000 to 12,000 lb./hr. depending on the fuel available leaving a load of 15,000 to 35,000 lb./hr. It is estimated that the lowest level that the current CWF atomizers can be operated at is 30,000 lb./hr.

The balanced draft fans were sized to allow for the addition of emission controls if required. A small change in the dampers can result in a large change in the air flow. In addition, the motor draws too high a load during cold start-ups which may require special procedures to correct.

The first 33 tonne tanker truck of CWF took 75 minutes to unload. It is felt this time can be improved. The two CWF tanks are capable of holding 75 tonnes each which should provide a total of four days operating supply.

3. Environmental Considerations

Mr. Peter Zwicker informed the Committee that a permit to operate has been received from the Department of the Environment. Two of the restrictions that have been placed on the operation are:

(1) opacity must not exceed 20%
(2) particulate emissions must be less than 250mg/standard m^3.

Dr. Thambimuthu suggested that these type of numbers could kill the technology. The opacity at Chatham used to be up to 40%, although with a 1/3 slipstream run through the baghouse, it could be reduced to 10%. If a baghouse is required, the cost may be too high. The really important issues, SOx and NOx, are not even addressed here. The cost of an opacity meter alone could be as high as $20,000.

Mr. Ed Bain questioned whether a meter would be required all the time or whether the stack could just be checked on a periodic basis. Also where did the Department of the Environment get these guidelines?

Dr. Phil Read noted that the requirements for a utility are no more than 50mg/standard m^3. If a baghouse is too expensive, we may have to look at a new technology.

Mr. Allyn Todd stated that the cheapest particulate removal system which appeared viable was a cyclone which should cost less than $100,000. However this was based on coal ash and not on CWF ash which will make a difference.

Dr. Thambimuthu agreed and suggested it was therefore very important to have Mr. Neil Stover carry out the proposed ash characterization program as soon as possible. This program will characterize the ash for various operating conditions. This data will be used to determine whether a suitable cyclone can be constructed.

Mr. Adrian White suggested the first priority is to get the boiler up and running on CWF and then issues can be dealt with as they arise. The Committee agreed with this suggestion.

4. Expenditures to Date

Dr. Thambimuthu stressed the importance of having all invoices to him by May 1, 1988. Mr. White stated that CBDC intended to meet this date. Bills for the Oil Substitution and Conservation Agreement for $358,000 have already been submitted.

Cost overruns to date total $93,000. The final figure will be approximately $110,000. It was agreed that the Oil Substitution and Conservation Agreement Management Committee be requested to cover this overrun.

5. Other

The Oil Substitution and Conservation Agreement Management Committee will be on site for a tour on April 27, 1988. It was agreed that it is premature to have the official opening until the boiler is up and running on a consistent basis.

The next Steering Committee meeting will be held at the Minas Basin site on May 31, 1988 at 9:30 a.m.

CARBOFUEL-MINAS BASIN PROJECT MINUTES

Steering Committee Meeting No. 7
Minas Basin Pulp & Power Co. Ltd.
Hantsport, Nova Scotia
1:30 p.m., May 31, 1988

Attendees:

Ed Bain, N.S. Dept. of Mines & Energy, Chairman
Phil Read, Energy, Mines & Resources Canada
Peter Zwicker, Minas Basin Pulp & Power, Co. Ltd.
Adam Bennett, National Research Council
Adrian White, Cape Breton Development Corporation
Greg Landry, Cape Breton Development Corporation
Kelly Thambimuthu, CANMET
Bob Kazmel, Cape Breton Development Corporation
Lorne MacNeil, N.S. Dept. of Mines & Energy
Allyn Todd, Cape Breton Development Corporation

1. Minutes from April 7, 1988 Meeting

The minutes from the April 7, 1988 meeting were reviewed and accepted as presented.

2. Update on Project Status & Technical Sub-Committee Meeting - May 30, 1988

Mr. Allyn Todd reported on the Technical Sub-Committee meeting held on May 30, 1988 and the actions which arose out of this meeting. A copy of the minutes of this meeting are attached.

Mr. Adam Bennett reviewed the work carried out to improve the flame quality. Much of the flame instability resulted from the high windbox pressure. After several different attempts to adjust the settings, seven 3-inch diameter holes were drilled in the windbox to provide tertiary air to the combustion zone. These have now been increased to eight 4-inch diameter holes. Flame stability has been much improved as a result.

Dr. Kelly Thambimuthu noted that tertiary air tends to improve your NOx emissions but too much will result in decreased carbon burn out. He also noted that a turn down of about 4 to 1 has been acheived. EPRI has considered 3 to 1 to be good for CWF.

Mr. Todd commented that the atomizer is generally working very well. There has been no problem in changing from oil to CWF - the transition is very smooth. To date, the lowest temperature at which the boiler has been started up on CWF was 207°F but it is hoped that cold light off can be achieved at 170°F.

To date, approximately 500 tonnes of fuel have been burnt over 260 hours of total operating time. An account of activities during commissioning (from March 28 to June 3) is attached.

3. Environmental Concerns

A number of stipulations have been included with the Department of Environment approval to operate the CWF boiler. These are attached.

Mr. Allyn Todd informed the Committee that quotes ranging from $19,000 to $30,000 have been received from three firms to carry out stack testing. For comparison, tests will be carried out on #6 burning oil, #7 burning oil and #7 burning CWF. Particulate will be measured on #7 only, while burning CWF. A decision will not be made until after conditions have been optimized.

Discussion took place on the proposal for particulate characterization which was received from Mr. Neil Stover of the Nova Scotia Research Foundation Corporation. Mr. Todd noted that the proposal can be broken down as follows:

Phase 1 - Section A - Collect particulate sample
Section B - Characterize sample

Phase 2 - Design appropriate collection system

Mr. Ed Bain questioned whether other companies had quoted on this work. The emissions testing companies are already equipped for particulate flow rate measurement and may be better trained for the work anyway.

Mr. Todd responded that companies had been approached for quotes and would be able to take samples from the stack. However, Mr. Stover would be better equipped locally to collect a quenched sample from the hopper. It is probably advantageous to have him take both samples because (a) he would not reduce his quote by very much for not having to take the stack sample and (b) it would be better to have the same people collecting the samples simultaneously.

Dr. Phil Read inquired whether Mr. Stover could obtain as good a stack sample as companies with appropriate equipment and expertise in the field. Dr. Thambimuthu replied that CANMET was willing to supply Mr. Stover with multicyclone collection equipment and would train him in its use.

Mr. Bain asked whether all the analyses proposed in Phase 1, Section B should be carried out. Dr. Thambimuthu felt it was important to obtain as much information about the particulate constituents as possible. There is no guarantee that a cyclone will work. Data such as resistivity may be critical to design an alternate collection system.

Dr. Read noted that the Oil Substitution and Conservation Agreement Management Committee have only agreed to fund the Phase 1 portion of this proposal. This is a cost overrun to the project made necessary by the Department of the Environment's stipulation sheet. The Technical Steering Committee recommended that CBDC enter a contract with the Nova Scotia Research Foundation to carry out Phase 1 of this proposal at a cost of $40,265. The existing contract between CBDC and the province (Oil Substitution and Conservation Agreement Management Committee) will be amended to cover this essential cost overrun. CBDC will appoint a sub committee to oversee this work. Mr. Stover's final report will be part of the deliverables from CBDC to the Management Committee.

Discussion took place on items 1 and 4 of the stipulation sheet. Mr. Bain questioned who will be taking the opacity readings. Mr. Adrian White responded that CBDC has talked to the stack sampling companies about carrying out a test. If the opacity exceeds 20%, methods of resolving the problem (i.e. adding cyclones, etc.) will be examined. After particulate control is installed readings will be checked again.

Mr. Greg Landry noted that the wording implies that a permanent opacity meter be installed. Mr. Bob Kazmel agreed. Even if you can meet the requirements when the stack is tested, changes in variables during operation may result in increased opacity.

Mr. Bain questioned whether other industries are required to have continuous opacity monitoring. Mr. Adam Bennett replied that monitoring is required for large utility stations but suggested someone check on the requirements for a unit of comparable size.

Dr. Read observed that stipulation #4 is really the important one. If you can meet this requirement now or by using a cyclone, etc. the other requirement will fall into place. What item 1 really says is that if you do get a puff of smoke, it can't last for more than six minutes. Mr. Todd agreed and noted if this occurred the boiler would have to be shut down anyway.

Mr. Peter Zwicker noted that the problem is being dealt with on a logical basis. Aside from any requirements that the Department of the Environment may have, the Minas Basin Pulp & Power Co. wishes to maintain good public relations. If complaints are received concerning excessive smoke, they will shut down anyway.

4. Alternate Usage of Steam Available

Mr. Bain observed that the current steam requirements at the Minas Basin Pulp & Power Co. site are lower than what the boiler is capable of producing. Are there other potential users for the steam? Could electrical co-generation be carried out on site?

Mr. Kazmel noted that a superheater would be required to obtain higher pressure steam for co-generation. Mr. Zwicker stated that 900 lb steam would be required if the back pressure was to be used for process requirements. Otherwise a condensing unit is necessary. The company has considered a 2 MW sized unit but at the current fuel costs, either a higher sale price for electricity or assistance with the capital cost of the equipment is needed to make it economical.

Mr. Bain questioned whether staff from N.S. Dept. of Mines and Energy could review this project. Mr. Zwicker responded that data could be made available.

Dr. Thambimuthu suggested district heating was a possibility. Mr. Landry pointed out that the capital costs for district heating were usually quite high.

5. Other

It was agreed that the date for the next meeting would be set after testing is complete.

Mr. White will arrange a date for the official opening.

Dr. Thambimuthu will look into preparing a sign.

6. Presentation on Combustion Aerodynamics

Dr. Thambimuthu qave a presentation on why the tertiary air ports stabilize the flame by distributing the air flow. Other alterations to the air register or the addition of a screen may achieve the same purpose and be more acceptable to boiler owners.

MINUTES

Technical Sub-Committee of the Technical Steering Committee for the Minas Basin Pulp & Power Coal-Water Fuel Conversion Project

Date: May 30, 1988 - 4:30 p.m. - 9:00 p.m.
Place: Minas Basin Pulp & Power, Hantsport, N.S.

Attendees:
Gordon Brenton - MBP&P
Bob Kazmel - CBDC
Allyn Todd - CBDC
Adam Bennett - NRCC
Kelly Thambimuthu - CANMET
Dave Burnett - MBB
Dave Lawrence - Lawrence Engineering

Minutes

The boiler inspection of earlier in the day was reviewed. Ash accumulations were not considered severe either in the furnace or generating tube bank. Most ash retrieved from these areas was light brown in color and appeared to contain virtually no carbon. A thin (1/2" to 3/4") layer of slag covered the furnace floor for the first ten feet beyond which a crusty, easily broken material appeared, giving way to the light brown ash about 6 inches in depth at the rear wall. Ash caught at the boiler exit may have been trapped by a slightly protruding lip in the ductwork at that point. There were no signs of erosion.

The refractory quarl showed signs of both impingement of coal particles and oxidation. In particular, a circular concave depression in the refractory was observed. It measured 7/8" deep, 8 to 10 inches across and was located at about the 2:00 position in the quarl. Slag (1/2 - 3/4 inches thick) coated the frontwall of the boiler below the burner throat extending down to the floor.

Samples of ash were taken from various places in the boiler. The second inner row of screen tubes were observed to have acquired a growth of ash whiskers, easily removed and again, pictures and samples were taken.

It was decided that floor slag would remain but the lighter and more easily removed ash could be removed. One bbl. of material was removed.

Better viewports were suggested: an improved rear one and a port sighting along the mud drum. Also, a second sootblower was discussed. MBB were asked to quote on these items.

The decision was taken to burn a further 1000 t of fuel before the next inspection, estimated to probably be 8 weeks time.

A deficiency list of items requiring completion on the boiler was compiled, a copy of which is attached.

The fuel strainers (3 and 4 foot baskets) proved a maintenance intensive item and have successfully been replaced by a smaller screen element with 1/8" holes. The requirement for cleaning out the strainers subsequently dropped from twice per day and one hour per cleaning to once every two days and 20 minutes per cleaning. An in-line CWF strainer has been ordered as of May 27 with 4 - 6 week delivery.

NRC will provide a high shear in-line mixer, previously used with good success in their labs in Ottawa, for breakup of agglomerated or flaked material which may be the origin of pebbly looking dried coal agglomerates forming or catching at the screen. No atomizer blockage has been observed with the new screen in use.

It was suggested that problems encountered with purging could be better controlled with a larger negative furnace pressure and/or repiping the oil feed line to allow a manual bleed-off purge. Also, additional water purge may be required on the CWF line (the last 3 to 4 feet).

Operating the furnace at negative 1/2" pressure should be possible to avoid excessive inleakage of tramp air.

A presentation on combustion aerodynamics and tertiary port firing was made by Kelly Thambimuthu. This gave rise to a lengthy and occasionally heated discussion on modifications to windbox and/or air register.

As a result, several items evolved including an action plan. In order to prevent the phenomena of an uneven combustion air pressure distribution occurring within the windbox, which currently appears to be the case, expanded metal could be installed inside the windbox and positioned so as to break up the existing air flow patterns. The decision was taken to order or have available on short notice the appropriate materials.

Availability of a 14-1/2" dia. primary swirler will be reported by Dave Burnett.

Estimates received to date for an ash removal system on the air heater hopper range from $2,200 to $24,000. Since the ash collected measures approximately 40% ash, the remainder is likely combustible and might be disposed of most efficiently in the wood boiler. A test will be conducted to evaluate this disposal method.

Ash characterization study work planned was reviewed briefly and proposed erosion study work was discussed. Erosion studies might be best conducted by replacing screen tubes with control sample tubes for the two year period. Several groups would be capable of such work.

The new gas ignitor (5 MMBtu/hr.) is on site and all necessary matchup parts have been fabricated and are available for installation and hook-up.

The NRCC atomizer has performed extremely well on both oil and CWF. 256 hours have been logged on CWF to date. 161 of those hours have been on the 60° Alumina/10% Zirconium ceramic and 95 hours have been logged on the 70° Alumina ceramic. A larger degree of wear has been observed on the 70° tip than on the 60° cone. It is estimated that the 70° tip will last for only an additional 5 to 25 hours on CWF. NRC agreed to provide two additional 70° tips. CANMET agreed to provide any additional funding required for ceramic work through an existing CANMET program with NRC.

The following action plan was developed for approval by the Steering Committee:

	Action Item	Responsible Party
1.	Order expanded metal for windbox if long lead time is required	A. Todd
2.	Remedy the deaerator steam pressure control problem	G. Brenton
3.	Repair or replace the feedwater flowmeter	G. Brenton
4.	Calibrate the O_2 analyzer	G. Brenton
5.	Provide 2 x 70° ceramic tip sets	A. Bennett
6.	Test various boiler operating parameters over a one week period and evaluate further action required.	K. Thambimuthu A. Todd

Item #6 on the action plan is tentatively proposed for the week of June 20 depending on the availability of personnel and equipment. If approval can be obtained by K. Thambimuthu, he will have two technicians bring equipment down from Ottawa to do gas testing for NO_x etc. and to do further air studies and optimization on HFO and CWF.

Following this testing, evaluation of further action will take place by the Technical Sub-committee, if necessary.

A problem plaguing the project all during commissioning has been the plant's ability to use all of the steam #7 boiler can generate. Line losses to the #5 boiler house were too large to permit #7 to carry full load. This problem has been relieved, at least in part, by the removal of a bottleneck in the steam delivery line. As of May 27, boiler #7 has been able to supply 51,000 lb./hr. of steam to #5 boiler house and run the mill with #5 shut down for 20 - 30 minutes. Excessive load swings in steaming rate on #7 prevented a longer test period, due to lack of proper control on feedwater flowrate and temperature (Items 2 and 3 on the action plan).

The action plan outlined above will be presented to the project steering committee tomorrow.

Attached is the daily operations summary for May 27, 1988.

Respectively submitted

Allyn Todd

Allyn Todd, P.Eng.
1988-06-15
AT:mlm

Distribution

Attendees
Lorne MacNeil
Adrian White

1988-05-31

BOILER #7 - ITEMS FOR COMPLETION

Pipefitters

Remove and replace feedwater flowmeter.
Remove and replace deaerator steam control valve and regulator.

Instrumentation

Install O_2 gas, regulators and calibrate analyzer.
Tune O_2 trim controller.
Repair or replace feedwater flowmeter and retune controllers.
Prepare OIU for audible alarm cancel and connect alarm to PCL.
Repair sticking CWF - PSID gauge.
Repair CWF atomization steam control line (refill?)
Tune oil & CWF flow controllers for Cascade operation.

Electrical

Install audible alarm on boiler trip.
Install ceiling fan circuit.
Raise power cable to ID fan off ground and off steamline.
Install propane "ON" light on boiler front.

Safety

Install additional lighting at rear of boiler #7.
Install improved stepladder at rear of boiler #7.
Audible alarm required for boiler trip.
Halon extinguisher system required for Control Room with temperature indication alarm to security.
Larger "No Smoking" signs/stickers required for Control Room.

General

*Solve deaeration control problem.
*Solve steam line problem.
Ship bbl's of fly ash to CBDC.
Install screen on manual outdoor FD damper.
Obtain nipple reducers and caps for 4" tertiary air ports. (On order.)
Grout sway pipes on stack.
Install ceiling fan (ordered).
Install sample port and temperature indicator on feedwater line from deaerator.
Install new ignitor.
Reroute air steam heater steam trap discharge away from heater footings.

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               MINAS BASIN PULP & POWER CWF FIRED BOILER
               ------------------------------------------                 1988
                           DAILY OPERATIONS SUMMARY               MONTH       5
                           ------------------------                 DAY      27


COMBUSTION                          MINIMUM    MAXIMUM    AVERAGE      TOTAL   BTU TOT.
----------                          -------    -------    -------      -----   --------
COAL/WATER FUEL (LB/HR)                  -2       6382       2644      63397     665674
OIL (LB/HR)                               0          0          0          0          0
AIR (K-LB/HR)                             0          0          0          0     N.A.
ATOMIZING STEAM (LB/HR)                   1       1153        735      17617     N.A.
OXYGEN (%)                                2          9          5   N.A.         N.A.


AIR HEAT                            MINIMUM    MAXIMUM    AVERAGE
--------                            -------    -------    -------
COMBUSTION AIR TEMP. (F)                140        331        261
AMBIENT AIR TEMP. (F)                    79        108         93
EXHAUST GAS TEMP. (F)                   268        581        438
HEATER EXHAUST TEMP. (F)                188        438        341


STEAM/WATER                         MINIMUM    MAXIMUM    AVERAGE      TOTAL   BTU TOT.
-----------                         -------    -------    -------      -----   --------
STEAM PRODUCED (K-LB/HR)                  0         51         25        590     589885
STEAM PRESSURE (LB)                     145        165        152   N.A.       N.A.
DRUM LEVEL (IN)                          -3          7          1   N.A.       N.A.


AUXILIARY                           MINIMUM    MAXIMUM    AVERAGE      TOTAL
---------                           -------    -------    -------      -----
SUPPORT STEAM FLOW (LB/HR)                0       2657       2037      48848
CHEMICAL FLOW (LB/HR)                     0         36          6        151

FURNACE PRESSURE (IN.)                   -5          4         -1   N.A.
ATOM.STEAM PRESSURE (LB)                 -3        151         87          0


        BTU'S IN        665674   NET STEAM OUT        523420
        BTU'S OUT       589885                             0
        EFFICIENCY          89                             0
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MINAS BASIN PULP & POWER BOILER COMMISSIONING REPORT

Boiler startup began during the week of March 28, 1988. The following account presents a daily description of activities during shakedown of the boiler system from March 28 to June 3, 1988.

Week 1

Mar. 28/88	- Manual atomization steam purge bypass installed. - Insulation being installed on lines. - Mounted main flame scanner on upper port. - Encountered foreign material in steam line - plugged steam side of atomizer. - Steam purge too large.
Mar. 29/88	- Set up steam purge limit. - Procured smaller auxiliary oil atomization tip. - Installed mirror for improved video viewing. - Problem with flame scanners (cables too short). - More foreign material in lines causing blockage.
Mar. 30/88	- Blew down steam line for 30 min. to clear foreign material. - Generated first steam in boiler at 3:13 p.m. on oil at about 13 MMBtu input, on auxiliary gun. - Oil flame impingement on boiler wall.

Hours Operation HFO = 6 Max.steam rate - 9,000 lb./hr.

Total = 6

Week 2

Apr. 4/88	- Inspected furnace interior. New refractory pulling away from old. - Labels stamped on air dampers. - Propane vent valve actuator overheating.
Apr. 5/88	- DOE granted conditional permit. - NRC arrived on site. - Railing on tank tops being installed. - Feedwater flow to drum meter requires repair. - Scanners rewired with new cable. - Foreign material caused blockage again.
Apr. 6/88	- Installed steam strainer & pressure gauge. - Mounted both scanners on upper port. - First shipment of CWF arrived on site (4 p.m.) - Propane vent valve malfunction. - Fuel offloading pump defective. - Propane delivery - 66 l.
Apr. 7/88	- NRC gun in. - #7 boiler carried the load while #6 down for repairs. 24000 lb./hr.
Apr. 8/88	- Fisher valve rep repaired feedwater flow meter. - Hi drum level alarm trip jumpered. - Steaming from 11:15 to Sun. 7:30 a.m.
Apr. 9/88	- Boiler operated around the clock on oil.
Apr. 10/88	Began flushing & preloading CWF system.

Hours Operation	HFO = 44 Total = 44	Max steam rate - 43,000 lb./hr.

Week 3

Apr. 11/88		Inspection of furnace interior - packed Kawool in separation between old refractory and new refractory quarl. Attempted first firing of CWF. Ignitor not large enough. Poor unstable combustion. Atomization appears good. Returned to oil firing.
Apr. 12/88		Low steam demand due to board mill being down; unable to switch to CWF.
	- 8:45 p.m. -	Began firing CWF and optimizing flame.
	- 12:00 p.m.-	Boiler trip and operators unable to restart on CWF.
Apr. 13/88	- 2:00 p.m. -	Installed atomization steam strainer.
	- 3:20 p.m. -	CWF rupture disk failure.
	- 7:45 p.m. -	Switched successfully and smoothly from HFO to CWF without changing atomizers.
	- 8:55 p.m. -	Boiler trip on low scanner air pressure.
	- 10:15 p.m.-	Switched from HFO to CWF, smoothly.
	- 11:30 p.m.-	Rupture disk failure, returned to oil firing.
	- 12:30 p.m.-	Problems with #6 boiler. Must keep #7 up on oil.
Apr. 14/88	- 9:30 a.m. -	Smooth switch to CWF.
	- 2.55 p.m. -	Rupture disk failure. Returned to oil firing.
	- 6:00 p.m. -	Boiler trip on propane pressure low. Ignitor had been left on.
	- 7:00 p.m. -	Shutdown to change atomizers and replace ruptured quick connect gasket.

- 8:00 p.m. - Feedwater flow control problem to drum identified.
- 11:56 p.m.- Using backup oil pump, achieved 50,000 lb./hr. steam on oil.

Apr. 15/88

- 8:30 p.m. - Meeting with P. Zwicker and G. Brenton to review items requiring completion.
- 1:00 p.m. - Cleaned CWF strainer #1. 2 inch layer of partially dewatered CWF caked on inside of screen.
- 3:00 p.m. - Boiler to stay on oil until Saturday when board mill will be down for scheduled maintenance Saturday thru Monday.
- Tremendous heat on top of fuel tanks due to no ceiling vent.

Hours Operation on CWF = 12-3/4 hours.
Max. Steam Rate achieved on oil = 51,000 lb./hr.
Max. Steam rate achieved on CWF = 36,720 lb./hr.

Week 4

Apr. 20/88	- 3:30 p.m.	- Meeting with Gordon Brenton re items requiring completion. No work accomplished since CBDC last on site on Apr. 15. Reason - all manpower removed from CWF project to work on MBP&P plant project.
		- Investigated deaerator steam control problem.
Apr. 21/88	- 8:30 a.m.	- Meeting with P. Zwicker and G. Brenton re getting some manpower. Only personnel available are electricians who must wait for materials to arrive.
		- Lindsay is in to inspect for ceiling vent/fan requirement.
Apr. 22/88	- 8:30 a.m.	- Boiler drum level low trip test. Problems with PCU discovered. Difficulty getting instrumentation personnel.
	- 10:45 a.m.	- Jeff Tracey assigned to repair PCU.
	- 2:50 p.m.	- PCU repaired. Modifications to CWF screen housing completed.

Hours operation = 0 hr.

Week 5

Apr. 25/88	- 7:35 a.m.	- Discovered OIU has locked-up the display screen.
	- 8:00 a.m.	- Pipefitters begin CWF line modifications.
		- 0.065" screens installed.
	- 2:45 p.m.	- Electricians wiring transformer to PCU/OIU.
		- Quotation received on ceiling fan - $11,000 (30,000 CFM unit)
Apr. 26/88	- 8:00 a.m.	- Awaiting OIU repair by MBPP personnel.
	- 10:30 a.m.	- Meeting with George Bishop re delays in project.
	- 1:30 p.m.	- NSPC visited site.
	- 2:30 p.m.	- Word received project to get top priority. Requested manpower available at noon Apr. 27.
	- 3:30 p.m.	- Propane delivered - 363 liters.
Apr. 27/88	- 8:00 a.m.	- OIU appears to be repaired. Preparing to fire up on HFO.
	- 10:30 a.m.	- Oil Substitution Committee visited site during start-up on oil. OIU locked up again.
	- 11:30 a.m.	- NRC atomizer developed oil leak at rear gland. Switched atomizers but ignitor went out and could not get ignitor restarted.
	- 2:00 p.m.	- Diagnosed ignition problem as scanner pressure low - too much instrument air being taken by ignitor.

Week 6

May 2/88	- 10:00 a.m.	Boiler light off on oil.
	- 12:00 a.m.	Switched to CWF.
	- 3:15 p.m.	Boiler trip, cause unknown. Ignitor problems trying to restart.
	- 10:15 p.m.	Back on line with CWF.
May 3/88	- 3:00 p.m.	Unstable flame developed. Operator switched guns and went to oil.
	- 8:00 a.m.	Boardmill down. #7 baseloaded on HFO.
	- 2:45 p.m.	First sootblow. 5 min. duration.
	- 3:30 p.m.	Attempt to switch to CWF failed due to ignitor problems. Disassembled both propane regulators - checked out o.k. Enlarged orifice to full bore.
	- 6:40 p.m.	Start up on HFO.
	- 9:15 p.m.	Switch to CWF @ 250 F air temp. Unstable without support ignition.
	- 10:50 p.m.	Ignitor off at 280 F air temp.
May 4/88	- 1:30 a.m.	Switched strainers. Lost flame in process from pressure change.
	- 2:00 a.m.	Switch to HFO.
	- 8:00 a.m.	Samples of strainer deposits taken. Ignitor problems again brought to MBB's attention. Larger one promised by Friday. Meanwhile modified air supply to existing ignitor. Sampled air hopper for catch.

	- 7:00 p.m.	Startup on HFO.
	- 8:30 p.m.	Switch to CWF
	- 9:30 p.m.	Fuel leak in pit cleaned up.
May 5/88	- 5:00 a.m.	After 3 boiler trips, switched to oil.
	- 5:30 a.m.	Attempts to switch to CWF failed. Oil temp escalated making restart on oil difficult.
	- 7:30 a.m.	Light off on HFO.
	- 8:30 a.m.	Boiler trip - low drum level. Back up immediately on oil.
	- 9:30 a.m.	Canada Cement LaFarge and NRCC visited. Switch to CWF (changing guns) unsuccessful. Foreign material caught in atomizer. Flushed fuel line.
	- 4:30 p.m.	Technical sub-committee meeting decision to install tertiary holes in front wall of boiler.
	- 5:30 p.m.	Boiler (on oil) taken off line to cool for mods.
May 6/88	- 8:00 a.m.	Began removing 4 window panels to relieve excessive heat near top of fuel tanks.
	- 4:00 p.m.	Manometers installed on burner for pressure measurements and cold test done.
May 7/88	- 8:00 a.m.	7 four inch holes drilled through boiler front wall and 3 inch nipples installed.
	- 11:00 p.m.	Established CWF flame - much improved combustion.

Week 7

May 9/88	- 8:00 a.m.	Boiler operating smoothly on CWF since Sat. night. Windbox press still high at higher boiler load - flame becomes unstable.
	- 3:30 p.m.	Boiler trip - propane pressure low prevented restarting boiler.
	- 8:00 p.m.	CWF flame established.
May 10/88	- 8.00 a.m.	Boardmill down. Steaming rate down to 12000 lb./hr. (1600 lb./hr. CWF). As air temp dropped, ignitor required to maintain stability.
	- 9:10 a.m.	Switch to HFO. Maintained low load all day.
	- 4:00 p.m.	Boardmill back on line.
	- 6:00 p.m.	Switch to CWF at 253 F air temp.
May 11/88	- 8:00 a.m.	Smooth operation on CWF all night. Adjustments to air flow and dampers made but could not improve on combustion.
	- 6:30 p.m.	Severe oscillations in furnace pressure observed.
	- 9:35 p.m.	Checked air heater hopper and atomizer for cause of oscillations.
	- 9:50 p.m.	Startup on CWF at 241 F air temp.
	- 10:20 p.m.	Oscillations have ceased (cause undetermined).

May 12/88	- 8:20 a.m.	Shut down boiler to switch to 80° tip on oil. Removed ash catch from air heater hopper (10½ hr. CWF firing only). Removed ¼ bbl. of ash.
	- 9:45 a.m.	Startup on HFO.
	- 11:00 a.m.	Switch to CWF on 70° tip.
	- 1:00 p.m.	Improper adjustment of atomizer resulted in major deposit on furnace floor and heavy emissions at stack. Switched back to oil to burn out deposit.
	- 2:15 p.m.	Soot blew for 5 mins.
	- 3:00 p.m.	Return to CWF with 60° tip.
May 13/88	- 4:00 a.m.	Strainer #1 isolation valve stem stripped. Boiler switched to HFO while cleaning strainer.
	- 6:00 a.m.	Switched back to CWF.
	- 7:30 a.m.	PSID gauge at strainers observed to be sticking.
	- 9:00 a.m.	Skewed flame and increase in fuel pressure. Shutdown to clean atomizer - wood fibre found lodged in atomizer. Crack observed in ceramics (alumina). Gun and fuel lines flushed.
	- 1:15 p.m.	Switched to CWF.
	- 1:30 p.m.	Site visit by Dept. of Mines & Energy.

Week 8

May 16/88	- 12:00 a.m.	Boiler ran smoothly all weekend on CWF. Shutdown to cool for windbox mods on Tues.
May 17/88	- 1:30 p.m.	All 3" nipples in windbox have been removed. An 8th four-inch hole placed in inner manway. All tertiary air ports are now 4" diameter. Cleaned out air heater hopper.
	- 7:30 p.m.	Completed air flow pressure measurements on windbox. NRC contacted to supply 70° tip.
May 18/88	- 7:30 a.m.	Delay in starting boiler while decision made by MBPP whether or not to support overtime for operators required to man both boiler houses.
	- 12:00 a.m.	Boiler started on HFO (60° Nitride tip). Adjustments to burner during afternoon to optimize on oil. #2 oil pump only capable of 2500 lb./hr.
	- 4:55 p.m.	Soot blew.
	- 5:10 p.m.	CWF tank level gauge not working.
	- 5:40 p.m.	Switch to CWF. Unsupported combustion but high degree of instability at 3700 lb./hr. CWF.
	- 7:30 p.m.	Reduced firing rate to 3000 lb./hr. Stability improved.
May 19/88	- 8:00 a.m.	Boiler operated all night on CWF with no problems. (2500 lb./hr. CWF avg.)

	- 12:30 p.m.	Small 1/8" hole plate installed in #1 strainer housing replacing 4 foot screen baskets.
	- 5:00 p.m.	Adjustments to burner settings improved combustion significantly. Achieved 41,000 lb./hr. steam (4270 lb./hr. CWF) on 60° tip.
	- 6:00 p.m.	Switched to 70° tip (Zirconium-Alumina).
	- 7:30 p.m.	Attained 43,570 lb./hr. steam at 4761 lb./hr. CWF (50 MMBtu/hr. input).
May 20/88	- 3:00 a.m.	Load down as low to 1800 lb./hr. CWF and 17000 lb./hr. steam for approx. 15 minutes. Air temp. dropped to 250 F but no signs of instability.
	- 8:30 a.m.	Firing rate reduced to 1741 lb./hr. CWF (18 MMBtu/hr.).
	- 10:00 a.m.	Air temp stabilized at 255 F, steam flow 16,280 lb./hr. and fuel flow 1739 lb./hr. CWF. Stable tightly swirled flame. Burner turndown of 2.7:1 clearly demonstrated.
May 21/88	- 10:20 p.m.	Boiler shutdown for weekend and cool down for mods to windbox on Monday.

Week 9

May 24/88		Pipefitters prepared 8 four-inch nipples for installation in windbox. Steam coil in air heater on all weekend. Windbox too hot to enter. OIU problems identified. Main steam line size increased at bottleneck over weekend.
May 25/88	- 7:30 a.m.	Small fuel strainer inspected.
	- 8:00 a.m.	OIU board replaced. Power outage over weekend possible cause.
	- 2:00 p.m.	4" nipples installed. Inspection of windbox revealed uneven secondary vane spacing - likely due to parallax error. Reset. 5 MMBtu propane ignitor arrived. Adaptor parts being fabricated in machine shop. 4' x 4' hole in ceiling opened for vent fan installation.
	- 7:00 p.m.	Light off on oil.
	- 7:27 p.m.	Raising steam.
	- 10:00 p.m.	Boiler #5 shut off and #7 carried plant at 150 - 155 psi with 5 psi drop from #7 to #5 boiler house (oil firing).
	- 10:45 p.m.	Switched to CWF without switching atomizers.

May 26/88	- 8:30 a.m.	Two trips reported overnight due to power outages/surges but back up immediately on CWF each time.
	- 1:50 p.m.	Boiler outage due to planned power interruption at plant.
	- 5:15 p.m.	Power back on. Boiler started on CWF at air temp 207F. Ignitor off after 10 mins. Air temp 211 F.
	- 7:00 p.m.	Problem developing with deaerator steam control valve causing huge fluctuations in feedwater temperature and boiler steaming rate.
May 27/88	- 10:15 a.m.	Removed small strainer basket after 36 hours continuous operation for cleaning and inspection.
	- 7:00 p.m.	Boiler shutdown for weekend. During afternoon, achieved 51,190 lb./hr. steam at 6329 lb./hr. CWF (66.5 MMBtu) for approximately ½ hour. Boiler #5 off line and 8 - 10 psi drop observed between boilerhouses. Heavy paper (grade 337) being run in mill.

Week 10

May 30/88		Boiler opened for thorough first inspection after operation on CWF. Details reported at Technical Steering Committee meeting on Tuesday.
	- 4:00 p.m.	Technical Sub-Committee meeting - refer to minutes.
May 31/88		Further inspection, measurements and photographs of boiler internals. Completed installation of new ignitor.
	- 1:30 p.m.	Technical Steering Committee meeting at Minas.
June 1/88	- 11:00 a.m.	Tried new ignitor for first time. Works perfectly and a vast improvement over the old one.
	- 12:30 p.m.	Fired up on oil.
	- 2:30 p.m.	Switched to CWF (70° tip) without changing guns.
June 2/88	- 7:30 a.m.	Wore out first atomizer tip (70°). Replaced with 60° (only one available).
June 3/88		CBDC off site. First commissioning stage completed.

Nova Scotia

Department of the Environment

Application for Approval
of
Industrial Waste Treatment Works

Minas Basin Pulp & Power Company Ltd.
(Name of Company or Other Owner)

File No.: 11-87-0180-10.2

Approval No.: 87-065

Project Description: Coal-Water Fuel Combustion at Minas Basin Pulp & Power Company Ltd.

Stipulations: Please refer to attached "Stipulation Sheet"

Recommended:

Approved:

MINISTER OF THE ENVIRONMENT

Date Approved: [illegible] 13 [illegible]

STIPULATION SHEET

MINAS BASIN PULP AND POWER

CWF BOILER

1. If opacity exceeds 20% for more than 6 minutes while burning CWF, the burner will be immediately switched over to bunker "C" oil.

2. Upon commissioning the boiler on CWF, a stack testing program will be implemented to determine the effectiveness of the tubular air preheater in removing particulates from the boiler stack emissions.

3. When the boiler is operational on CWF, a monitoring program will be established to characterize the particulate emissions and determine the requirement for a collector for the system. The necessary stack tests will be carried out within three months, and the control equipment defined within a further three months.

4. Particulates in stack emissions shall not exceed 250 mg/Sm^3.

MINAS BASIN - COAL WATER FUEL CONVERSION PROJECT

Steering Committee Meeting No. 8
Cape Breton Development Corporation
Glace Bay, Nova Scotia

Wednesday, December 14, 1988
10:00 a.m.

Attendees:

Ed Bain, N.S. Dept. of Mines and Energy, Chairman
Peter Zwicker, Minas Basin Pulp & Power Co. Ltd.
Allyn Todd, Cape Breton Development Corporation
Kelly Thambimuthu, CANMET
Barclay Cunningham, Cape Breton Development Corporation
Ron Nicholson, Cape Breton Development Corporation
Lorne MacNeil, N.S. Dept. of Mines and Energy

1. Events Leading to Fuel Supply Cut Off and Future Plans for the Project

Mr. Ron Nicholson reviewed the recent events which led to this meeting. In late November, the boiler was shut down for approximately six weeks in order to carry out the Bailey logic reconfiguration. At that time, the fuel storage tanks at both CBDC and Minas Basin were full. CBDC is also currently experiencing a cash flow problem because of the large coal inventory they are carrying. They have been attempting to cut costs whereever possible but particularly on projects without a short term payback. The decision was made to curtail operations at the coal water fuel plant. Discussions with the union resulted in a premature release of the information to the press. The current plan, however, is to continue to operate the plant with a single shift. This would provide more than enough fuel for Minas Basin. Fuel required for other tests would have to be "stacked up" over time.

One of the main incentives for keeping the plant in operation at this time is that NSPC has indicated they will need additional power and are interested in converting the No. 1 unit at Point Tupper to coal-water-fuel. A submission has been made to Committee on Atlantic Coal to cost share a conversion study. If this looks promising, it's very important to have the Minas Basin boiler available to help refine the combustion process. By the end of June 1989, there should be enough information available to decide whether the coal-water-fuel plant should continue to operate.

A consortium has also been put together to look at building a large scale plant. Bechtel is one member with experience in the field. Over the next couple of months, they will be updating the 1986 Fenco study. They will be looking at the options of building at Victoria Junction (to make use of fines) or at Point Tupper ($5 per tonne to ship coal vs. $20 per tonne for coal water fuel). CBDC will also be doing some research to cut costs by reducing the stabilizer required to make the coal-water-fuel (the Point Tupper site could use the fuel directly without storage).

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Dr. Thambimuthu questioned whether any testing work was planned to be carried out at the Macaan power plant during 1989. Mr. Nicholson responded that if the Point Tupper study looked positive, Macaan would be used to prove the burner scale up.

Mr. Bain inquired as to what the long term viability looked like for coal water fuel. Mr. Nicholson stated that the CBDC subsidy for fuel production has been in the order of $2,000,000/year so far and would continue to be of this order while working on combustion development. CBDC has been committed to coal-water-fuel and is assuming the price of oil will eventually go back up to the point where the fuel is viable. However, at the present time, some sort of incentive is required to keep the plant going, and given the present tight money situtation, it is doubtful whether the program can be subsidized indefinitely.

Dr. Thambimuthu noted that the federal government has spent in the order of $18,000,000 on coal-water-fuel to date. A lot depends on the plant continuing to run and retaining the expertise that has been built up. He suggested that Minas Basin could apply to ACOA to subsidize the fuel costs. Mr. Zwicker commented that Minas Basin had already put in a proposal to ACOA: they would only be prepared to submit an additional request if they were sure the initial request would not be jeopardized.

Dr. Thambimuthu noted that we are currently experiencing an aberration in time. Earlier on, we would have been pleased to have coal-water-fuels at this stage of development to replace oil. In the future, coal water fuels will fill the gap as environmental restrictions lead us to cleaner coal burning technologies. The CBDC coal-water-fuel contains less sulfur than some oil and NO_x emissions at Minas Basin have been cut by 50%. Japan, Italy and the United States are all interested in continuing work on coal-water-fuels.

Mr. Nicholson remarked that Puerto Rico is still interested in CBDC's coal-water-fuel but the details will still have to be negotiated. The Italians have told Puerto Rico that CBDC's mixture is the best they have burned. He also suggested it would be useful to CBDC if governments would support coal-water-fuels for strategic purposes.

Dr. Thambimuthu asked whether some form of press release could be made to indicate that CBDC is committed to coal-water-fuel. Mr. Nicholson replied that they had tried to diffuse the situation right at the beginning but the press would not believe them. The best publicity will be obtained by starting the Minas Basin boiler back up again.

Mr. Bain questioned how Minas Basin Pulp & Power felt about coal-water-fuel. Mr. Zwicker responded that it required somewhat more effort than burning oil because of ash clean out, etc. but they were happy to continue using it as long as the fuel supply was available.

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2. Preliminary Report on CWF Fly Ash Characterization

Dr. Thambimuthu distributed some preliminary graphs on the CWF fly ash material. The ash appears to form hollow spheres like popcorn. The particles look like they are greater than 100 um in diameter but are collected as if they had an effective aerodynamic size of about 6 um. This suggests that we need something that will collect material from 5 to 15 um. It will probably require a multicyclone to collect over this range.

Mr. Cunningham questioned why we were concentrating on cyclones for ash removal or whether we even need an ash removal system. Mr. Zwicker noted that residents in the immediate vicinity of the boiler have responded to the perceived pollution - material they have seen deposited on their cars, etc. As part of the community, the Minas Basin Pulp & Power Company does not want to upset the residents. Dr. Thambimuthu observed that electro static precipitator (ESP) or baghouse would very likely do the job but the costs would be prohibitive for a small user. We need to develop a system that's simple and cheap. It is expected that a multi-cyclone can do the job. However, only by installing such a system can we determine how effective it really will be and carry out research to optimize performance.

Mr. Nicholson asked what the present ash levels were in the fuel. Mr. Todd replied that the fuel was made with thermal coal resulting in 4% ash in the CWF. Dr. Thambimuthu questioned whether metallurgical coal could be used in the interim. This should cut emissions in half and would also reduce the amount of ash that would have to be removed. Mr. Todd responded that metallurgical coal could be used or a second bank of flotation cells could be added to reduce the ash. However, we will still need some back end emission clean up.

3. Bid Review of Fly Ash Removal System

Mr. Todd reported that a cyclone appears to be the cheapest system that can achieve the removal efficiency we require (>90% removal). Waste material will be trucked to a landfill site once per week. Equipment manufacturers have used data on fly ash that was generated by Nova Scotia Research Foundation Corporation. Bids are expected to be finalized early in the new year with delivery 17 to 22 weeks after the order is placed. Manufacturers have indicated that installation costs would normally be equivalent to equipment supply prices.

Mr. Bain questioned whether there would be room for the equipment at the back end of the boiler. Mr. Zwicker responded that the area was not very roomy. Whether the equipment will fit or not will depend on its size and configuration. Mr. Todd added that the tender package to the suppliers had included site drawings and specified where the collector would have to go. The ash may have to be conveyed 30 feet to a storage silo in a location that is accessible for truck pickup. This would probably be in an area that would require piles. Mr. Todd estimated that the total cost for this job will be in the ballpark of $200,000.

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The Committee discussed possible funding arrangements for this portion of the project. The Canada-Nova Scotia Oil Substitution and Conservation Agreement Management Committee has agreed to provide funding for half of the cost of this work, up to a maximum of $100,000. The contract with CBDC will be revised to this effect, once the remainder of the funding has been committed from some other source.

Mr. Nicholson stated that CBDC had been budgeting for this expenditure but under the current financial restraints it will be impossible to provide these funds in this fiscal year. It will be tough to sell the idea of putting $100,000 in next year's budget to cover this if the plant is only going to operate for a few months. Mr. Zwicker said that Minas Basin would be prepared to put up the required funds now, provided they would be reimbursed in the future (bridge financing).

Mr. Bain questioned when CBDC would be in a position to make a commitment as to what funding they can contribute for this work. Mr. Nicholson responded that a decision should be made by the end of January 1989.

Dr. Thambimuthu suggested that the ash collection system could be funded under the Committee on Atlantic Coal as a research project. If it is accepted, CBDC's cost can be shared on a 50-50 basis with CANMET. The fly ash is appreciably different from that produced by pulverized coal combustion and will be particularly difficult to remove for high swelling coals. As a minimum, a multi-cyclone system will be required to properly remove the particulate. We have to make sure the equipment manufacturers understand what we want. We should ask them to guarantee the removal efficiency of their equipment for a range of conditions.

Mr. Bain proposed that we ask for a turnkey operation. The manufacturers should be asked to supply the equipment, install it and guarantee its performance. We should see if they have some sort of pilot plant in which they could test the collectability of our ash.

Mr. MacNeil noted that because of time constraints, the Oil Substitution and Conservation Agreement Management Committee has agreed to pay their portion based on a manufacturer's quotation being approved by the Technical Steering Committee and an order being placed by the end of January 1989. Mr. Todd is to arrange to have the equipment manufacturer on site to quote on a turnkey system. It will be early February before we receive the quotes. Mr. Bain proposed that the information be faxed to the Committee members when it becomes available and a phone poll used to decide which equipment to purchase. This will keep delays to a minimum.

4. Minutes of May 31, 1989 Meeting

Discussion on the minutes was concentrated on the "Action Items" which are covered under the Update of Boiler Modifications (below).

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5. Update of Boiler Modifications

Mr. Todd distributed an "Update on Minas Basin Pulp & Power CWF Conversion Project - June 1, 1988 to December 8, 1988 (copy attached).

One piece of work, which was not included under the "Action Items", was the installation of a high shear mixer to reduce plugging of the atomizer. This was removed when it developed a leak. Using a finer mesh screen in the fuel strainers and adding a screen wiper seems to have reduced this problem.

A tertiary air sleeve was installed and tried (with the ports capped) but this resulted in unstable operation. The ports were uncapped and a good flame was achieved at the upper end. A maximum steam output of 58,000 lb/hr was obtained on oil and 52,000 lb/hr was obtained on CWF. However, because of air inleakage through the tertiary air sleeve (even when it is completely shut), the low end performance has deteriorated.

6. Bailey Logic Reconfiguration

Mr. Todd reported that they had initially brought Bailey in to look at improvements to the flame scanners to upgrade boiler safety. Major problems were traced to the boiler logic. Because everything was so closely linked, the entire system will have to be reconfigured at a cost of approximately $25,000. Bailey should be ready to recommission the system by January 16, 1989.

Mr. Bain questioned who would be paying for this work. Mr. Todd replied that the onus is presently on Minas Basin to pick these up. However, they are valid project cost overruns. CBDC would consider sharing these costs in the future but is not in a position to do so at this time. The Committee agreed that the Canada-Nova Scotia Oil Substitution & Conservation Agreement Management Committee be requested to cover these overruns.

Mr. Cunningham questioned whether any other modifications were foreseen for this fiscal year. Dr. Thambimuthu suggested a soot blower (costing $6000 to purchase and $6000 to install) might be required. Mr. Todd proposed that lowering the ash level in the CWF may solve the soot problem. He also noted that other problems may appear after the logic system is recommissioned.

7. Transfer of Boiler Title

The Technical Steering Committee agreed that the boiler title should be transferred to CBDC providing this will not affect any future payments under the Canada-Nova Scotia Oil Substitution & Conservation Agreement. Mr. MacNeil to confirm that Dr. Read is in agreement with this decision.

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8. Action Items

Mr. Todd reviewed the action items discussed during the meeting:

(a) CBDC will provide a letter to Mr. MacNeil by January 31, 1989 indicating they are prepared to support the costs of the emission control system.

(b) Minas Basin Pulp & Power Co. Ltd. to investigate ACOA or Enterprise Cape Breton funding for fuel or transportation costs.

(c) CBDC to try to reduce the ash in the CWF by 50%.

(d) Boiler title to be transferred to CBDC provided it does not interfer with future funding.

(e) Mr. Neil Stover be requested to supply ten copies of his ash characterization report.

(f) CBDC will conduct a more detailed assessment of the ash collection system supply and installation costs. CBDC will consult with the Technical Steering Committee before placing an order.

(g) CBDC to submit a proposal to the Committee on Atlantic Coal to support the ash collection system as a research and development project.

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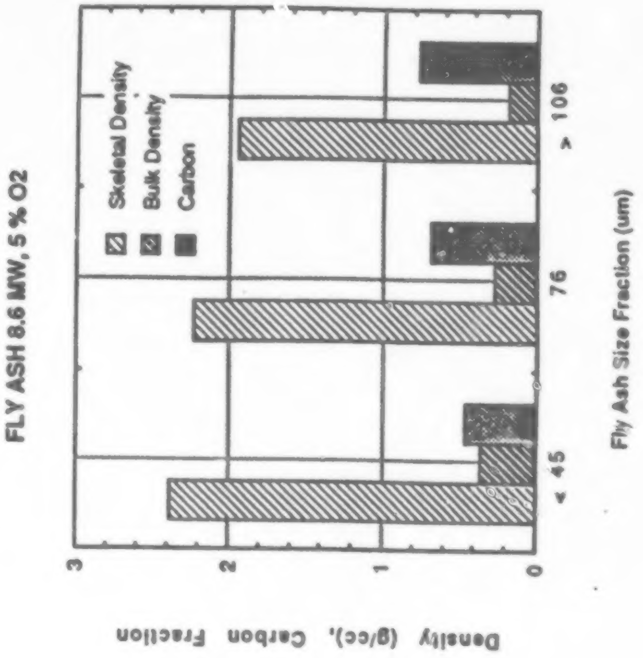
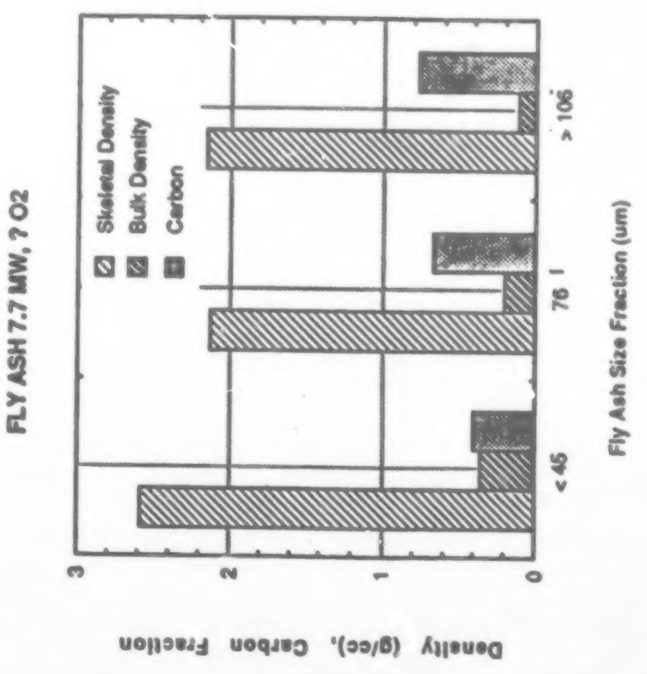
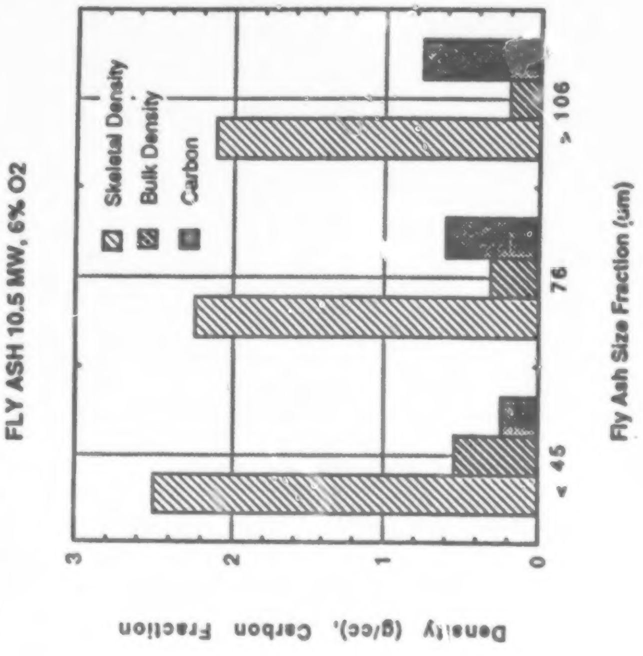
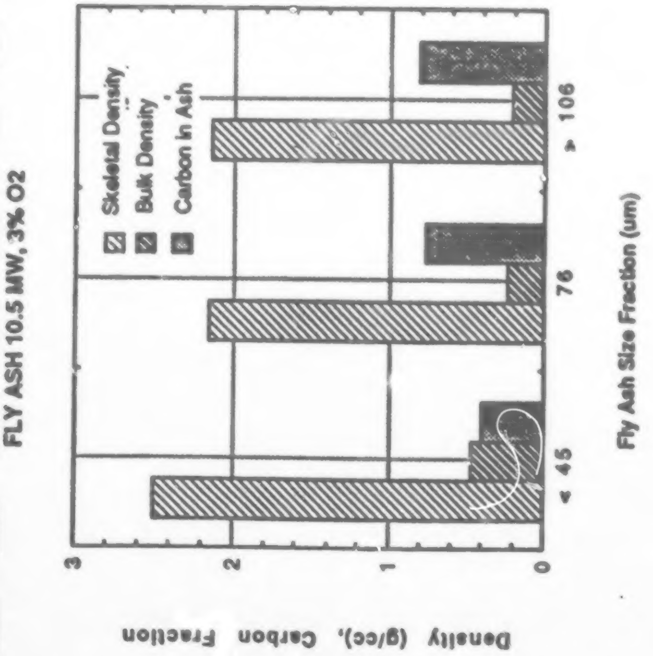
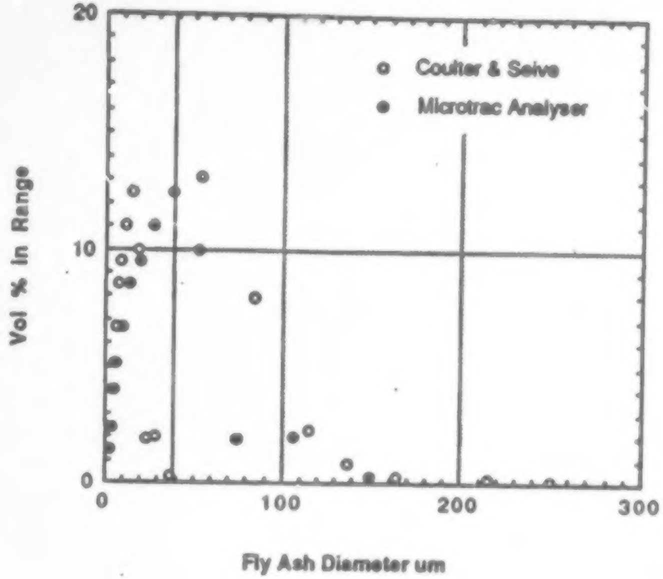

FLY ASH 8.6 MW, 5 % O2


FLY ASH 7.7 MW, ? O2

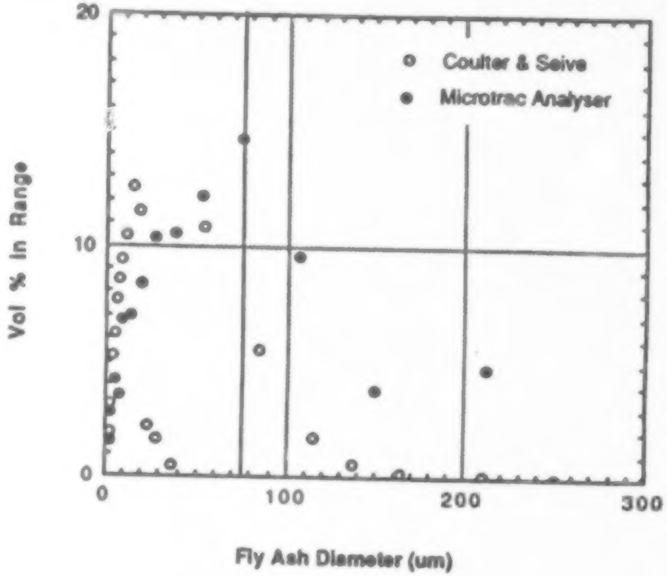

FLY ASH 10.5 MW, 6% O2


FLY ASH 10.5 MW, 3% O2

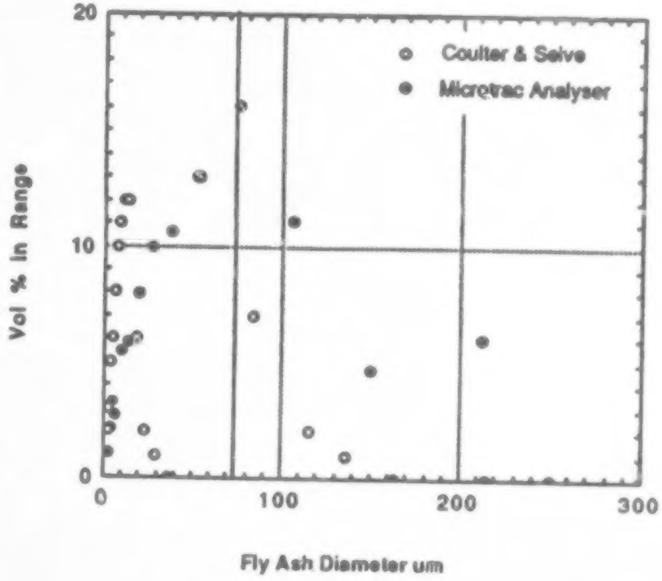
RUN 1 SIZE DISTRIBUTION FLY ASH 10.5 MW, 3% O2



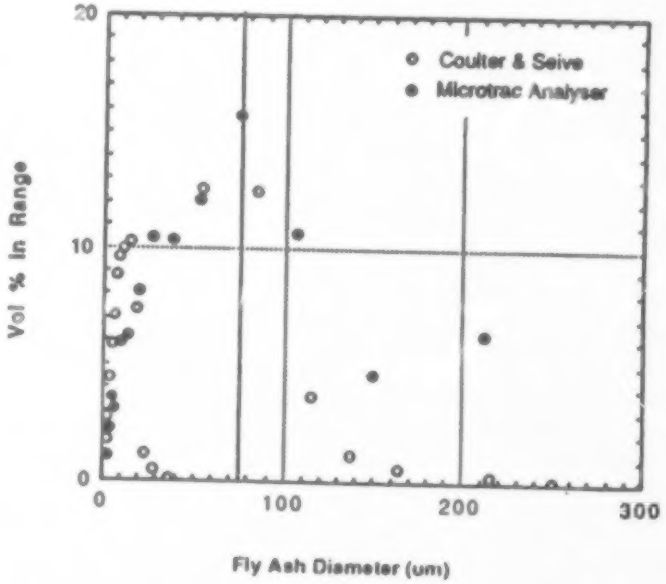
RUN 2 SIZE DISTRIBUTION FLY ASH 10.5 MW, 6% O2



RUN 3 SIZE DISTRIBUTION FLY ASH 7.7 MW, ? % O2



RUN 4 SIZE DISTRIBUTION FLY ASH 8.6 MW, 5 % O2



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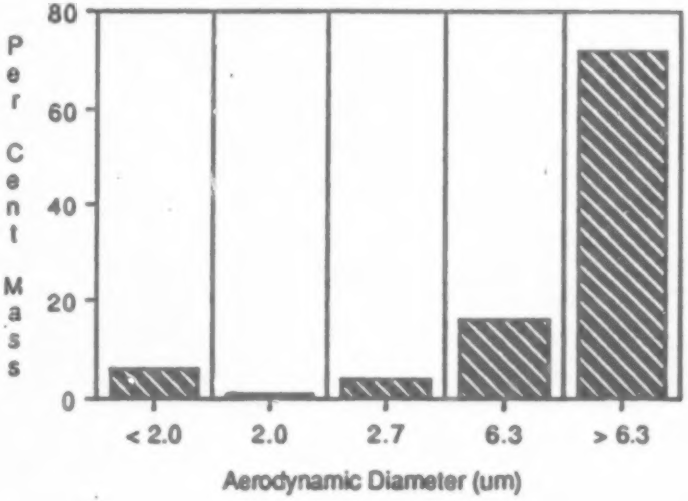
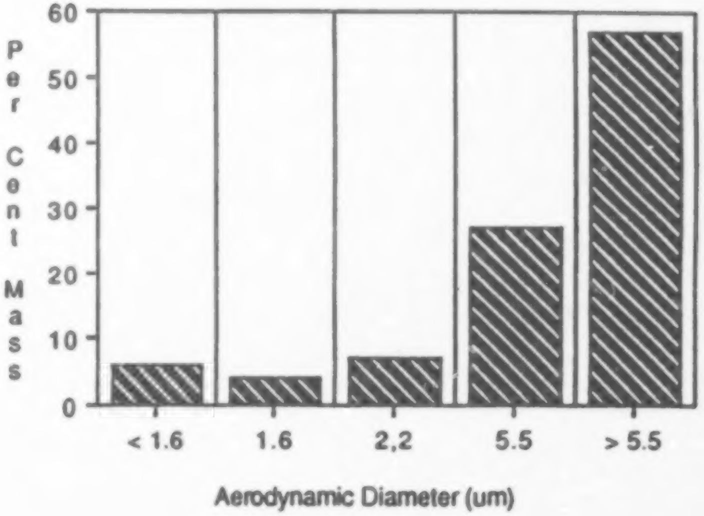


RUN 1 MULTI-CYCLONE FLY ASH



RUN 2 MULTI-CYCLONE FLY ASH

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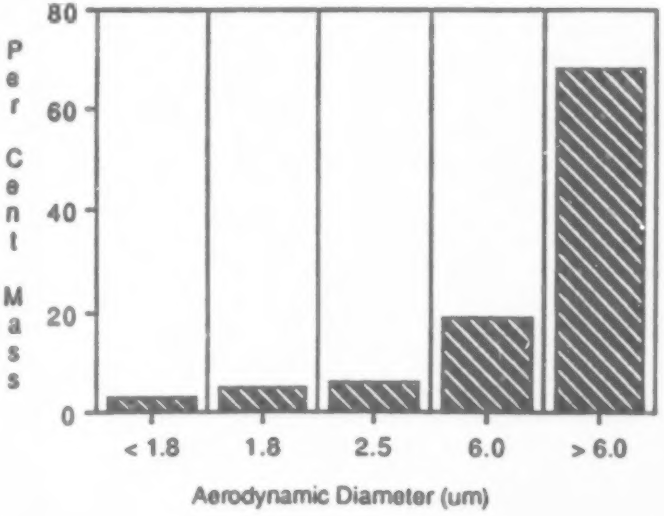
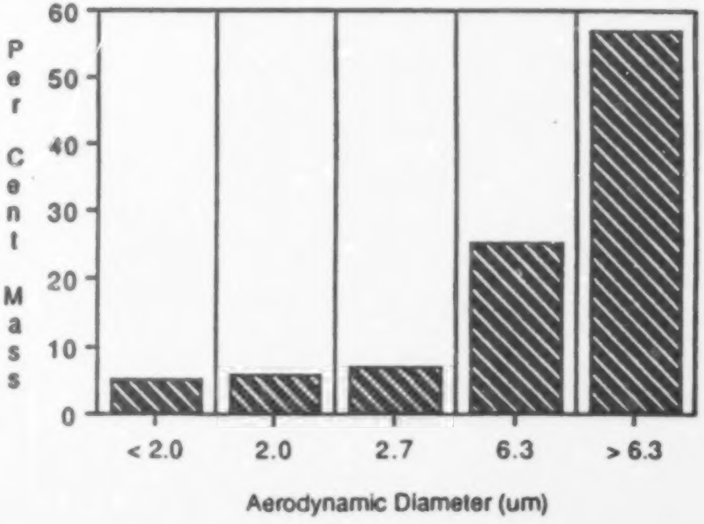


RUN 3 MULTI-CYCLONE FLY ASH



RUN 4 MULTI-CYCLONE FLY ASH

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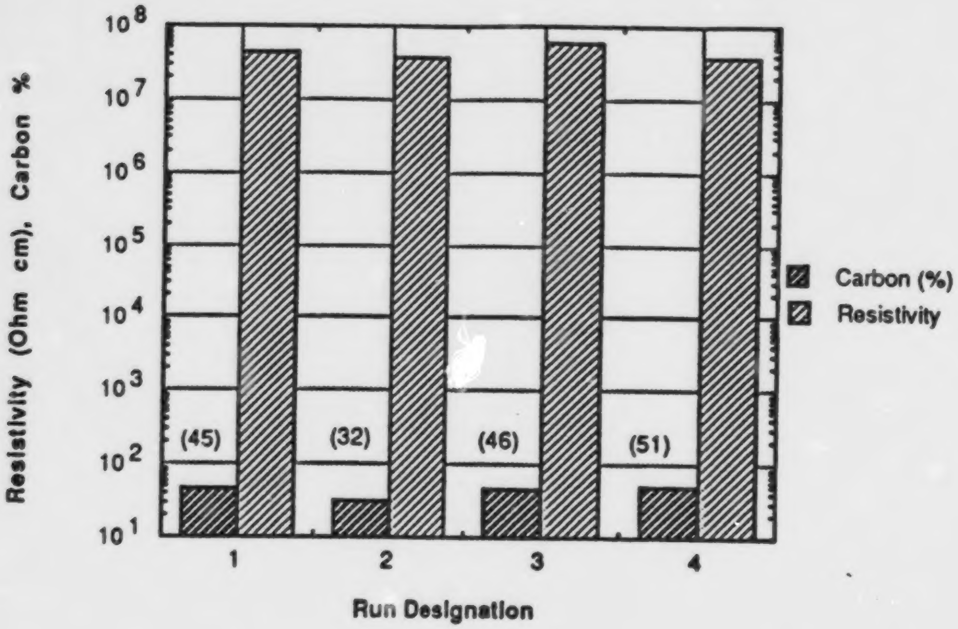
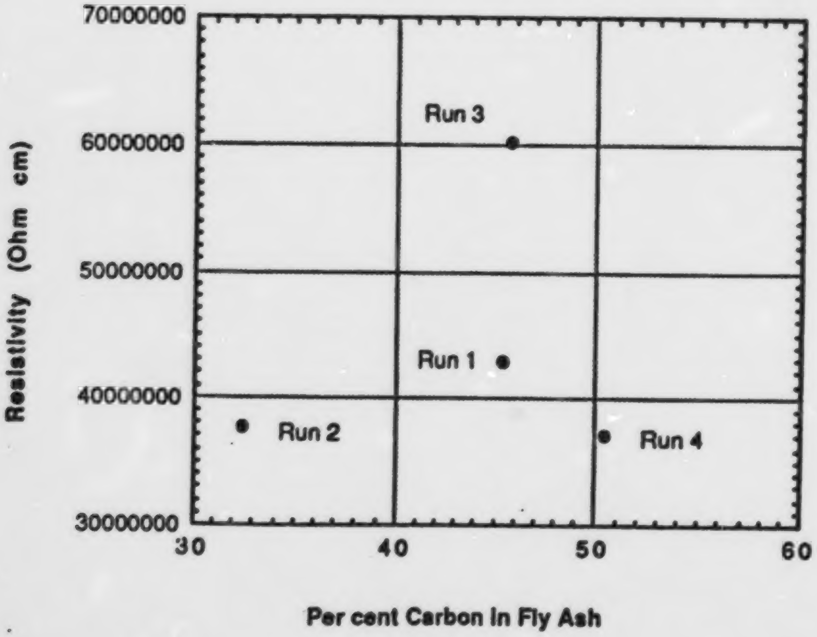
FLY ASH RESISTIVITY AND CARBON IN STACK TESTS

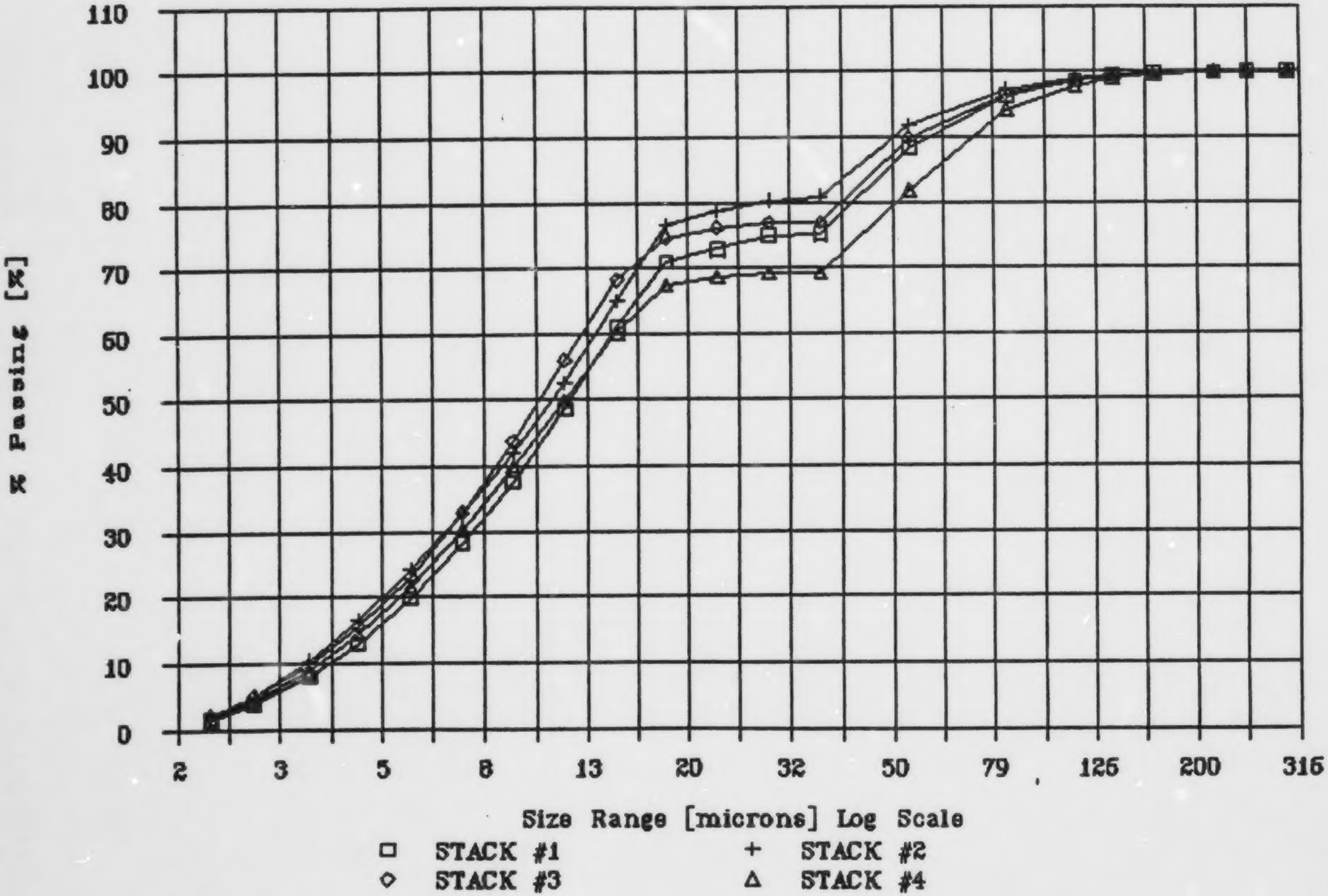


FLY ASH RESISTIVITY VERSUS CARBON CONTENT



MINAS STACK SAMPLE COULTER DATA (NSRF)

88-10-27



Hg POROSITY DATA FOR STACK SAMPLES,DAT COLLECTED AT NRC OTTAWA

		***** stack # 3 ***** size range < 45 um	45-106 um	> 106 um	
TOTAL INTRUSION VOLUME	(cc/g)	2.0378	4.1083	8.2787	
BULK DENSTIY	(g/cc)	0.3613 22.6	0.2166 13.5	0.1150 7.2	} lb/ft³
APPARENT (SKELETAL) DENSITY	(g/cc)	1.3693 85.5	1.9703 123	2.4167 150.8	

WHERE,
THE TOTAL INTRUSION VOLUME IS THE TOTAL PORE VOLUME,
THE BULK DENSTIY IS THE DENSITY OF THE MATERIAL INCLUDING ALL VOIDS,
THE APPARENT (SKELETAL) DENSITY IS THE DENSITY OF THE MATERIAL,

SUMMARY OF THE SEM PHOTOS OF THE STACK ASH

THE SCANNING ELECTRON MICRROSCOPE PHOTOGRAPHS OF THE ASH SAMPLES FROM THE STACK SAMPLES WERE DIVIDED INTO THREE SIZE FRACTIONS;

(A) <-45 um
(B) 45-106 um
(C) > 106 um

THE MORPHOLOGY OF THE THREE SIZE FRACTIONS FOR ALL OF THE FOUR STACK SAMPLES APPEAR TO BE SIMILAR UPON INITIAL VISUAL EXAMINATION.

THE RANGE (A),< 45 um, HAD A MIXTURE OF THE FOLLOWING;

ROUND PARTICLES THAT APPEARED TO BE ASH THAT HAD REACHED THE ASH FUSION TEMPERATURE,
FLAT PARTICLES THAT ARE VERY POROUS,
A SMALL AMOUNT OF ANGULAR PARTICLES THAT ARE NOT POROUS.

THE RANGE (B),45-106 um, WAS PRINARILY BROKEN AND INTACK CENOSPHERES.

THE RANGE (C),> 106um, WAS SIMILAR TO THE RANGE (B) PARTICLES.

UPDATE ON MINAS BASIN PULP & POWER CWF CONVERSION PROJECT
JUNE 1, 1988 to DECEMBER 8, 1988

Since the last Technical Steering Committee meeting on May 31, 1988, several modifications, tests, and furnace inspections have been carried out. The work completed is outlined chronologically under the following respective headings. One Technical Sub-Committee meeting was held August 15 and 16, the minutes of which are attached.

Modifications

June 1/88 - 5MMBtu/hr. Ignitor Installed

Reason: Original ignitor supplied by MBB of inadequate size and design.
Result: Immensely improved ignition flame.

June 20/88 - Installed NRC High Shear Mixer in CWF Delivery Line

Reason: Fuel plugging in the atomizer should be reduced if any dried fuel lumps could be broken up before reaching the atomizer.
Result: Plugging of atomizer decreased slightly but mixer developed severe leak at seal and operation was discontinued on June 24. Mixer removed from system on July 14.

July 5/88 - Feedwater Sample and Temperature Sensor Ports Added

Reason: No sample port previously existed and temperature was difficult to monitor.
Result: Easier to take daily samples and monitor temperature.

July 25/88 - 13½" Primary Air Can Reinstalled and Burner Screen Removed

Reason: Boiler operators experienced great difficulty establishing and maintaining stable CWF flame at any load for more than a few hours. Buildup in burner throat could not be avoided.
Result: Immediate return to stable running conditions of June. 35,000 lb./hr. appears to be the steaming limit.

July 27/88 - Finer Mesh Screen added to Fuel Strainers

Reason: Excessive gun pluggage was thought to be caused by dried fuel from the tank getting past the strainers.

Result: Reduction in atomizer blockage.

Oct. 11-15/88 - Tertiary Air Sleeve, Damper and Windbox Screen Installed

Reason: See Technical Sub-Committee minutes for August 15-16, Section 6 (attached).

Result: Improved steaming capacity of boiler, tested to 58,000 lb./hr. on oil and 52,000 lb./hr. on CWF. Stability at low firing rates not as good.

Nov. 18 - Dec. 9/88 Flame Scanner and Control Logic Improvements

Reason: Flame scanners not viewing flame properly and startup/shutdown sequencing identified to contain unsafe elements. Boiler shut down until modifications are completed.

Result: Improved flame sighting by ignitor and main flame scanners. Startup/shutdown control sequencing modified to render safe operation. Bailey Controls Ltd. contracted for this work.

Site Tests

Reports on the following site tests will be submitted with the final report.

1) July 11-15/88 - EMR gas and particulate rate tests.

2) Sept.26-30/88 - NSRF fly ash collection for characterization.

3) Nov. 7-10/88 - ORTECH gas analysis and particulate rate test.

Boiler Inspections

Reports for the following noted boiler inspections are on file and will be included with the final report:

1) April 4/88
2) April 11/88
3) May 30/88
4) July 4/88
5) Oct. 11-15/88
6) Dec. 8/88

Allyn Todd

Allyn Todd

1988-12-08

AT:mlm

T6

MBP&P CWF Project
Technical Sub-committee Meeting
August 15-16, 1988

NRC-ARL, Oxford St.
Halifax, N.S.

PROCESS
AUG 29 1988
TECHNOLOGY

Minutes of Meeting

Attendees

Bob Kazmel - CBDC (Chairman)
Gordon Brenton - MBP&P
Kelly Thambimuthu - Canmet
Allyn Todd - CBDC
Dave Burnett - MBB
Adam Bennett - NRC
Greg Landry - CBDC
Dave Lawrence - Lawrence Engineering (Aug. 16)

August 15

1. Review of Minutes from meeting of 1988-05-30

Allyn reviewed the items from these minutes. The nature of the flyash was noted, and was considered as not serious. The fuel strainers were successfully replaced; the in-line mixer installation discussed at this meeting has since been installed and tested and its effect was considered positive. NRC have submitted a proposal for a new high shear mixer and CBDC will issue a P.O. The purging problem with the fuel line was readdressed; it was felt that the problem could be alleviated by: (1) replumbing with more direct lines, (2) relocating the automatic valve in the CWF line to a point closer to the flushing inlet, and (3) increasing the flushing water inlet pressure (the steam pressure was also felt to be interfering with purging but can not be eliminated). It was decided that action should be taken on the changes to improve purging. Allyn noted that the ash characterization study by NSRF has been approved and sampling/-testing will begin by late September or early October; results should be available by November.

The new gas ignitor has been installed since the previous meeting, and is operating well. The action plan from the meeting was reviewed and all items have been taken care of. Steam problems related to line size problems are still under consideration by MBP&P. Gordon noted that there are problems in restarting on CWF after a short shutdown; it is necessary to change settings to restart. The problem is possibly related to fuel drying and could perhaps be reduced by increasing the fuel velocity. Adam illustrated a technique to achieve this with an insert into the fuel line of the gun reducing its cross-sectional area and thereby increasing the flow velocity. A few other problems from the past were noted, namely fuel drying in the storage tanks (should improve ventilation), Bailey PCW software and fuel/steam pressure differential (probably need a new steam regulating valve).

A few other items from these minutes were deferred to the appropriate area in the agenda.

2. Flyash disposal

The flyash disposal relates initially to flyash collected from the air heater, but must eventually address a flyash collection system for the flue gas stream. Proposals based on basic data from MECL and MBP&P were discussed. They represented several options, including three pneumatic systems (see attached summaries). Dave Burnett feels the simple wet venturi system (as used by Bowater-Mercey) is a safer type; pneumatic systems have problems with unburned carbon and sparks.

As far as ash collection is concerned, Dave also felt wet systems are safer. The Waterloo scrubber and other wet scrubbers are perhaps the best alternatives. The various dry systems (multicyclones, baghouses and electrostatic precipitators) each have some drawback, such as lower than acceptable efficiency or higher than acceptable cost. Nonetheless, it is felt that ash collection alternatives should be investigated before the results of the NSRF study are complete. It is also felt that an ash disposal system should be put in place as soon as possible because the problem at Minas is immediate. Although the wet disposal system (venturi airlock) is inexpensive and effective, there is the dewatering and effluent to deal with (CBDC has two screen units which can be considered for the dewatering). Examination of the system at B-M and evaluation of conditions at MBP&P over the next few days will help in the decision.

3. Boiler ash removal

The removal of ash from the boiler proper was discussed. Bob has previously received a quote from MBB on a clean-out door at the rear of the boiler (gas pass side) for $3,480.00, (copy attached). Clean-out requirements would also require a door at the back corner of the boiler to rake or vacuum ash. This opening would be approximately 14" x 16" and would allow for personnel access by cutting and welding tubes in the area. MBB will requote on this work to include all the items. The work will be scheduled for September.

4. Review of ceramics

A total of 13 atomizer tips have been supplied to MBP&P. Adam outlined some of the various tips, including two silicon nitride and the various alumina and alumina-zirconia at 70° or 60° angles. The longest burn was with the alumina - 10% zirconia at a 60° angle; the nozzle was dropped and broken. In order to better determine the life and problems with atomizer tips, the operators should keep track of them in their log book, noting any changes. Bob brought up the Canmet contract for ceramic work and mentioned his discussion with Williams & Wilson (Coors Ceramics); they are a large commercial ceramic company with expertise in materials and production. They have been informed of NRC's work and NRC has since had some contact with them.

Williams & Wilson's capabilities will be further pursued by NRC. Current thinking from work at NRC-ARL is that perhaps 35% Zirconia is required in the ceramics. Long-life (1000 hr) of the ceramics is the objective of the Canmet sponsored work; materials and production are to be investigated.

Adam also updated the meeting on the status of the high-shear mixer for MBP&P. The small unit presently in place will be removed and returned to NRC. It successfully demonstrated its function and although it was difficult to say absolutely that it made an improvement, it appeared to do so; it certainly did not cause any atomization/combustion problems. The new mixer will have double mechanical seals and will, therefore not have the leakage problems of the test unit. The seals represent the longest delivery time (Adam is awaiting further information on the seals). The cost of the mixer is $16,000.

August 16

5. EMR test results

Allyn first reviewed some of the operating results. In particular, he noted some results on oil firing; on Apr. 14 60.9 mm Btu/hr was achieved, but only for a matter of seconds and was not considered as very meaningful because it was from the time of the high windbox pressure (before tertiary air ports were drilled). Other results from May 12 (39.5 mm BTU/hr) and July 12 (36.5 mm BTU/hr were noted. The vanes on both the primary damper and the secondary damper are typically set wide open, and Bob questioned this (why are they needed?). Kelly said they are required for air ratioing if necessary, but they are normally wide open. Adam felt the oil flame was better with the secondary air cut back, and also that the burner burns CWF better than oil. Kelly again described the burner as essentially a CWF burner with oil burning capability.

Some results on CWF were discussed from the operating data. A high of 66.5 mm Btu/hr was reached on May 27 for 20-30 minutes (the windbox pressure was not recorded, but was probably 7"-9"- Dave Burnett said that one could expect say 6"-9" on a modern day oil burner at full load). The next highest firing rate was 52.7

mm Btu/hr on July 7 for about 1/2 hour, but the stack was dark (this was with the 14 1/2" can, installed on July 4). Gordon felt that high load operation has always been poor. No sustained high firing rates have been held because of plant conditions (not boiler problems), but other factors related to the burn would probably prevent such firing anyway.

Allyn and Kelly described the EMR emission testing. From July 6-14 the boiler burned mostly CWF and a total of almost 100 tonnes was used (about 50 tonnes of CWF was burned during the three days of actual testing, July 11, 12 and 13). However, problems were encountered beginning late on July 12; the flame would go bad and various steps were taken by way of purging, line flushing, mixer start-up, and so on, but the burn continued to falter. Tip plugging was suspected, but no actual blockage was ever noted according to Allyn. He and Kelly were quite puzzled by this turn of events and at the time of test end the boiler was burning oil. Nevertheless, the NOX results were encouraging to Kelly, with lower levels recorded than for other comparable tests.

Bob and Adam confirmed the operating condition on Monday, July 25; it would run OK for about 1 1/2 hours, then the flame would go bad, or even out. This condition was reported by MBP&P operators since the time the EMR tests were completed; some adjustments were made, but no sustained firing could be achieved. Bob and Adam noted that the gun was extremely hot when removed (oil bubbling and flashing). They decided to change back to the smaller (13 1/2") can and remove the lower half of the diffuser. This immediately allowed sustained firing - the boiler has run steady most of the time since the change. The main concern now is why such a difference was noted upon making these changes. Bob suspects the high temperature condition of the gun and something to do with it (fuel drying?). Kelly explained that the recirculation pattern with the larger can will in fact result in a hotter zone close to the atomizer. The same fuel was burned after the change as before and there were no problems, so the fuel was felt to not be directly responsible for the poor firing with the larger can.

Bob mentioned at this time his concerns over: (1) complaints about fuel conditions without proper discussion with CBDC and, (2) communication with unauthorized personnel at MBP&P, both of which can be damaging to the overall project. All communication should be directed to CBDC management or to Gordon Brenton at MBP&P, as appropriate.

Discussion continued on the burner performance/capability. Dave Burnett stated that for conventional oil firing a 5:1 turndown can be expected; 2:1 is normal for pulverized coal firing (3:1 is exceptional). He suggested that for the range expectations of the #7 boiler two burners may be necessary; in this way the low load requirements would be met by firing one of the two burners.

Bob feels the existing range of the burner is 25-35 mm Btu/hr and Gordon confirmed this, noting that even oil firing above this range is poor. Dave Lawrence reminded the meeting that the decision last year was for oil firing below 30 mm Btu/hr (the burner was considered 30-55 mm Btu/hr on CWF). There is now the consideration of other applications for the burner (NSPC, MECL, etc.), and the need to ensure its development is in line with the overall CWF program.

The MBP&P and MECL applications were quite different. Dave Lawrence felt that the conditions/results at MECL misled people as to the Canmet burners capabilites; he did point out, and it was agreed unanimously, that the Canmet burner is a very good burner (certainly better than the Coen burner), but that it has a different range than initially thought.

Kelly felt the upper limit of the burner is higher than the 35 mm Btu/hr generally considered the present limit, and Allyn agreed; Allyn, however recognized the unsustained burn at any observed higher rates and felt this was a valid concern with respect to the burner's actual capability. Dave Burnett suggested "fixing" the boiler to allow sustained high loading by providing for steam venting; the questioning of whether or not the tertiary air ports should still be used was raised because they are unconventional.

The effect of this air is essential to the boiler operation at present. Kelly felt some benefit may be gained by using a 15 1/2" primary can if no tertiary air were available.

Dave Lawrence presented data showing the square inch opening of several burner types; the general situation is about 500 sq. in. for 55 mm Btu/hr (from extrapolation of a "generic" design). The 23" Coen burner at MECL is 425 sq. in. and was a nominal 55 mm Btu/hr. The 20" Canmet burner at MBP&P is only 314 sq. in; the 8 x 4" openings (tertiary ports) make a total of 415 sq. in. Dave suggested modifying the burner by increasing its diameter with the addition of a tertiary air sleeve. The concept was illustrated and it was decided to discuss it with the action plan.

6. Action Plan

The main course of action for the #7 boiler will be to carry out the "fix" to allow sustained firing at high load (say 60,000 lb/hr of steam on oil firing). Kelly felt this would be a problem because of the air ratioing - the register is essentially set up for CWF, and he suggested that the oil flame will be smokey at high rates with the 13 1/2" can. The general understanding of the meeting was that an attempt should be made to verify the boilers limits, and this "fix" represents the only practical approach. The importance of the extra air from the tertiary ports cannot be neglected and the modification providing for the tertiary air sleeve is considered a worthwhile attempt. The action plan was, therefore formulated as follows:

(1) modify the burner front to accommodate the tertiary air sleeve; the existing tertiary ports will be capped.

(2) install vent line (3"-4" line, muffler and steam vent valve).

(3) concurrently, modify one of the MECL burners to increase the secondary air inlet (extend blades) and secondary cone diameter; the modified burner can be used at MBP&P if necessary.

This action plan will give two possible alternatives to the present problem of inadequate range (upper limit). They are recognized as attempts only, but under the present operating conditions something must be done. If these attempts are not successful, then the boiler can be returned to the present conditions.

There were several other suggestions to go along with the action plan. Relocation of the camera to the rear of the boiler should be considered (instrument cabinet probably available from AECL). The stack should be monitored (O_2 monitor part due in mid-September - Allyn will pursue this after checking with Scott at MBP&P). Replacement of the flame scanners under warranty (expires after November) should be done. In order to undertake the action plan, MBB should submit a new quote to include the following:

(1) new 70% open area screen at the top of the windbox (widest part).

(2) modification of the burner throat and design, fabrication and installation of the new tertiary air sleeve.

(3) modifications to the MECL air register as previously described.

(4) drawings of the changes, including floppy disks.

(5) clean out doors as discussed yesterday.

(6) supply and installation of vent line.

MBB will submit this quote to CBDC as soon as it is complete. The tentative date to carry out the work will be the week of September 19. CBDC will investigate the availability of a muffler from AECL, but Dave will price a commercialially available one anyway. It was also decided to have NRC to provide further tips, including 60° and 70° ceramic tips and an 80° stainless steel tip; CBDC will place the order for these tips.

The meeting ended with a list of concerns drawn up by Gordon. Most of these had been addressed during the meeting. These items are listed on the attached page.

Minutes Prepared By: Greg Landry

Greg Landry
Plant Engineer
Process Technology
Coal-Water Fuel Plant

GL/kb

Attachments

c.c.: Attendees
A. White

1988-08-25

FLYASH DISPOSAL

SUPPLIER	SYSTEM	COST
PROMAT	pneumatic system, completely installed and automated as neccessary	$24,773
UNITRAK	mechanical (helix conveyor) flyash removal to disposal (23 ft)	$9,730
FULLER-TRAYLOR	Venturi Eductor and Regenerative Blower (piping and installation not included)	$2,642 +
SULLIVAN STRONG SCOTT	"dense-phase" pneumatic conveying with control panel (piping and installation not included)	$25,436 +
JOY	Wet Venturi Airlock (installation and dewatering not included)	$3,500 +

FLYASH COLLECTION

SUPPLIER	SYSTEM	COST
GERBER	2-75" cyclones (rotary airlock valves required in negative pressure applications--not included in price)	$9,116us +

M.B.B. Mechanical Services Limited
P.O. Box 39 Lakeside, Halifax Co. Nova Scotia B0J 1Z0
Phone (902) [illegible] Telecopier (902) 876-8402 Telex 019-22793

DEVCO - COAL DIV.
ORIGINAL
JUN 21 1988
A
ACCOUNTS PAYABLE

June 14, 1988

CAPE BRETON DEVELOPMENT CORPORATION
P. O. Box 2500
Sydney, Nova Scotia
B1P 6K9

ATTENTION: R. Kazmel

Dear Bob:

REFERENCE: Minas Basin Pulp & Power Ltd.
CWF Demonstration
Wash Out Doors, Boiler Rear Wall
MBB 2-1852

We are pleased to quote for the supply and installation of two (2) insulated steel doors to be located in the rear, just above the mud drum, to assist in observation and clean out.

We quote as follows:

Material F.O.B. site, taxes extra	$1,070.00
Installation Labour	2,410.00

This price is valid for 30 days.

Yours truly,

MBB MECHANICAL SERVICES LIMITED

DJB

D. J. Burnett

DJB/sb

RECEIVED
JUN 21 1988
C. B. D. C.
C B CARBOFUEL

August 3, 1988

1. Should be able to produce maximum steam load on No.7 before winter heating load starts.

2. Should have small burner installed to maintain and hold steam load when changing over from C.W.F. to bunker.

3. Correct smoke problems with both fuels on high loads.

4. Fall out from stack, should be corrected as soon as possible.

5. Large build up of materials in furnace. problem should be looked at.

6 - Having Problems with Primary air dampers.

7 Problems with C.W.F. in fuel tanks. (Caking)

8 Problem with C.W.F. burner plugging on low load.

APPENDIX F

MINUTES OF THE TECHNICAL SUB-COMMITTEE

MINUTES OF MEETING

Location: V.J. Boardroom, Cape Breton Development Corp.
Date: September 15, 1987 - 9:30 a.m.

Attendees:			
	Kevin Jonasson	)	NRC
	Adam Bennett	)	
	Kelly Thambimuthu	)	Canmet
	Dave Lawrence	)	MBB
	Bob Kazmel	)	CBDC
	Joel MacLean	)	
	Greg Landry	)	
	Allyn Todd	)	

Minutes

A review of recent burner performance at MECL highlighted the following facts:

- To date the only modifications to the Canmet Model 1000 Burner are the single lever (as opposed to 3) primary damper control, the improved sliding action of both primary and secondary air dampers, and addition of straight section to primary can collar.
- Switching from HFO to CWF was done easily with appropriate purge/flush cycles and required no changes to secondary air vane positions. Also no adjustment was required to the atomizer.
- Approximately 400 t of CWF were burned in a total of 150 hours non-continuous burning time.
- Longest period of continuous operation was 43 hours, August 26-28/87.
- Average firing rate was 67 MMBtu/hr. ranging from 32 MM to 80 MM. 30 MM is expected to be the minimum.
- A burner turndown of at least 2:1 has been demonstrated.
- Steam/fuel ratio calculated at 0.13 when firing at 74 MMBtu/hr. This ratio is expected to be higher at lower fuel flow rates.
- Average steam pressure at gun = 120 psig. sat. The steam is ratioed at a 30 psi pressure differential with the fuel.

- 3/4" steam and CWF lines were replumbed to 1" diameter lines. The line pressure loss was reduced from 100 psi to 20 psi.
- Position of ignitor, behind the primary swirler vanes does not overheat the atomizer nozzle tip. Ignitor flame is anchored well out in front of the tip.
- Flame scanners operated well. As CWF was ramped up close to 90 MM, however, CWF spray momentum carried ignitor point further into furnace and the scanner saw black and indicated flame out.
- Atomizer linear expansion is between 1/4 and 3/8 inches. Fibrefax packing fills the steam heater jacket inside the gun and acts as a heat shield to the gun body. No air is required for cooling down the burner guide tube.
- Both primary and secondary air dampers were kept wide open. Radial spacing between primary damper and triangular slotted air guide is too great and permits only coarse adjustment to air flow.
- Atomization spray angle of 60° appears adequate for oil and CWF.
- Windbox pressure of 3 - 5 in. W.C. appears best.
- T.C.'s in primary swirler and secondary vanes showed 800F and 500F respectively. A maximum of 700F is recommended to prevent oxidation.
- The burner attachment to boiler front wall via a sliding fit works well and permits expansion while preventing uneven torsion from installation misalignment. Essentially all air leaks have been eliminated.
- A 0.050" mesh screen is employed in the fuel delivery system to eliminate foreign material or large solids from reaching the atomizer. This screen size appears adequate. Larger sizes tried were not. With one burner operational, the strainer required cleaning once every 24 hours. Cleaning is necessary when the pressure drop reaches 40 psi across the strainer. Strainer samples are being analyzed by CBDC.
- Atomizer fuel gap on CWF was 0.035". 0.020" is recommended for HFO firing but this is to be tested and demonstrated at Minas for the optimum settings.

- The CWF pump performed well but at the higher burner flow rates (e.g. 80 - 90 MMBtu) the pump was operating under extremely high pressures (order of + 200 psi) and since supplying only one of a potential 5 burner supply capacity, the pump flow rate was low. Since the pump is a positive displacement type, pump speed was slow and the cooling fan, direct-coupled to the pump shaft, consequently turned too slow to adequately cool the motor. The motor overheated and shut the burner down. This would not happen in a 5-burner application or where a pump is sized for one burner only.

Modifications to the Canmet Model 1000 and NRC atomizer for the Minas Basin CWF conversion were discussed. The following points were raised:

A) Canmet Model 1000

- No change to the secondary air vanes is required. Cheapest method of fabrication is best.
- Improper overlapping of vanes is no longer a concern.
- External adjusters for secondary air vane position should be changed such that once set up, they can be covered up and left. Appearance would also be less ominous. The Tee handles can be removed and replaced with nut heads and a universal handle used for adjustment. Pointers should be moved as close to the protractors as possible to eliminate parallax error.
- A sealing unit is required for the ignitor.
- The sealing arrangement for the gun can be shortened and will shorten gun length.
- 6" gun position range adjustability should be retained.
- "OPEN→" should be stamped on the damper levers and graduations numbered for reference.
- Secondary vane welds could be lightened up.
- Sealing should be retained on the secondary damper for air control.
- A general review of boiler front for gas tightness should be made.

- Putting the Canmet Model 1000 Burner on CAD is necessary for new drawings. Cost is estimated by MBB at about $2000. Kelly Thambimuthu (KT) indicated funds were available but no mechanism presently existed to get these dollars from the MECL budget. The MECL SC blessing is required before the money could be released. MBB's original proposal was based on the original CBDC drawings. Modifications identified require new drawings. About 1 week would be required to put them on CAD. KT will respond to MBB re this issue.

B) NRC Atomizer

- The NRC atomizer tip cap requires beefing up with wrench groves for better removal.
- Quick disconnect will be designed by NRC. MBB will match the design for quick connects on the supply side and also on the Y-Jet oil gun.
- A work station should be installed for flushing and clamping the gun, complete with quick connect fittings. Bob Kazmel will talk to Minas Basin re supplying a workstation. MBB to advise on what is required.
- Thermocouple in the gun will be type K and will extend into gun to within 4" of tip.
- NRC requested further information on commissioning cost provision for NRC personnel on site. A. Todd to respond and to issue revised specifications for atomizer as soon as possible.

NRC suggested that a technical sub-committee (TSC) be set up, appointed by the Project Steering Committee (SC). Its existence would ensure a direct communications link and reporting vehicle among the technical people involved in the combustionm, controls and performance side of this project. Kelly Thambimuthu agreed to raise this issue with the Steering Committee at its meeting on October 1. It would be comprised of the following members: Bob Kazmel, Peter Zwicker, Joel MacLean, Kelly Thambimuthu, Adam Bennett, Kevin Jonasson, Greg Landry, Dave Lawrence and Allyn Todd. Reports of any meetings of the TSC would be circulated to the SC. Weekly updates could be circulated among TSC members to keep everyone appraised of technical problems/resolutions and boiler performance data as it becomes available. It was generally felt by all that such a communications link would greatly enhance the technical team effort required. Fears were expressed that if Steering Committee trends developed similar to those established by the MECL Steering Committee, it could spell the demise of the Minas Basin project. Input from a TSC could contribute to the prevention of this happening.

An update on the Minas Basin project was given by Bob Kazmel. Civil site drawings for concrete work have been released for approval. Once approved, excavation would begin within one week, possibly as early as next week. Minas are removing a buried day tank on site this week. MBB are now transporting equipment to Five Island Lake. The boiler will sit on CBDC siding for 2 weeks and is scheduled to arrive on site October 21, followed by 9 weeks for installation. January 5 is presently scheduled as start-up target date. The air heater components and ID fan have been ordered. Critical path items were ordered by both MBB and CBDC on schedule. The boiler stack will go directly to Minas Basin.

Discussion on sustaining the boiler load at low steam demand centered on various strategies for maintaining a fire during switching from CWF to oil and vice-versa. Switchability has been effectively demonstrated on the NRC atomizer from CWF to oil but when flushing during the switch-over, process steam flow may drop. Therefore, support oil firing must be available below 30 MMBtu/hr. thermal input. It was decided that the best method would not be co-firing of HFO and CWF due to difficulties in control, plumbing and burner configuration. Instead the burner arrangement will consist of the Canmet Model 1000, NRC atomizer, propane ignitor mounted below the NRC atomizer in the primary air housing and an auxiliary 30 MMBtu Y-Jet oil atomizer mounted above the NRC atomizer and extending through the primary air swirl vanes. This would permit uninterrupted firing when demand drops below or rises above 30 MMBtu thermal input. In addition, an 82.6 MMBtu Y-Jet oil atomizer (standard industrial type) will be supplied as a back-up unit for oil firing, if needed. MBB will submit quotations on auxiliary and main oil atomizers.

Submitted by: Allyn Todd
Allyn Todd, P.Eng.

1987-09-24

c.c. - Mr. A. White
Mr. J.C. Campbell
Attendees

MINUTES OF MEETING

TECHNICAL SUB_COMMITTEE OF MINAS BASIN PULP AND POWER CWF CONVERSION STEERING COMMITTEE

November 28, 1987

submitted by

ALLYN TODD, P.ENG.

Location: MBB Mechanical Services Ltd.
Lakeside Industrial Park, Lakeside, Hlfx.Co., N.S.
Time: November 26, 1987 - 1:30 p.m. - 4:00 p.m.
Attendees:
Dave Lawrence) MBB
Dave Burnett)
Kelly Thambimuthu) CANMET
Adam Bennett) NRCC
Gordon Brenton) MBP&P
Bob Kazmel) CBDC
Allyn Todd)

Minutes

It is necessarv to view the old MECL register before approving its acceptance as suitable for the MBP&P installation.

A new secondary air cone is required with 3 centering bolts (2 on bottom, one on top). The 13-1/2" primary air swirler will be employed. Hence, secondary air cone will be 13-1/2" I.D.

Spider legs on stainless steel atomizer support tube are to be removed completely.

A 5MMBtu/hr. propane ignitor gun will be positioned at 9:00 in the burner assembly and extend through the primary air can to just behind the primary air swirler. Ignitor to be supplied by Fossil Power.

An auxiliary oil gun and atomizer (30 MMBtu/hr.) will be positioned at 12:00 in the burner assembly and extend through the primary air can and swirler. Auxiliary unit to be supplied by MBB.

A six inch insertion depth adjustability range is required on the ignitor, auxiliary gun and primary air can and swirler. Quick connects (Hansen type) will be used on the ignitor and auxiliary gun.

A burner gun cart is being made by MBB to hold 2 NRC atomizers, auxiliary gun and main oil atomizer. MBB will supply a standard main oil atomizer (Y-Jet type) rated at 80 MMBtu/hr., 100 psi oil, 100 psi steam, for commissioning the boiler on oil and as a backup atomizer when and if required.

The primary air guide slotted sheet will be located as close as possible to the primary air damper.

T-handle stumps, remaining after original modification of burner to single T-handle primary air slide damper mechanism, will be removed.

High temperature grease will be used on all internal moving friction surfaces.

The rope seal on the secondary air damper will be retained. The secondary air damper will also be shortened to save on material.

Tolerances are to be put on the new drawings. MBB to discuss this with CANMET. The $3,000 being paid to MBB by CANMET for an engineering review should include tolerances.

The secondary air vane adjuster T-handles (18 in total) will all be removed and replaced by hex-head type lockable adjusters. New coverplates will be fabricated to cover the adjusters and an aluminum scale for each adjuster will also be mounted beneath the cover.

Air Damper positioner T-Handles will be stamped with numbered, one-inch graduations and open arrows (e.g. OPEN →).

The main atomizer gland seal arrangement will be moved closer to the register body. The adjuster/tube lock assembly will be deleted and the seal gland used for locking the tube assembly in place. Graduations from 0 to 6" will be placed on the tube assembly and the gland ring used as a pointer.

The decision was made to dedicate one NRC atomizer to CWF and a second one to HFO. This will avoid any requirement to change gap when switching between CWF and HFO. (Not expected to be a frequent requirement.)

The NRC atomizer could be lightened by removing the outer tube but production is already underway.

The CWF gun mounting assembly will be via quick release block (identical on oil) and CANMET will supply 1" I.D. x 2 ft. flex lines for commissioning only. Hard piping will follow after the CWF burner has been commissioned. NRC presented a quick connect block drawing to MBB - required for MBB to design and fabricate the main oil atomizer gun connection fitting.

An air sealing arrangement between the gun and tube is to be attached to the guide tube assembly and used to seal all guns inserted in the guide tube.

The refractory constituting the boiler front wall will be a plastic refractory, 80% alumina. Insulation will be on site (fibrefax or equivalent) for shielding the tube walls near the front wall if required.

Viewports - One on the rear, 6" diameter, cost included in tender.
- One on the side viewing the burner throat area, 3" diameter, $900 cost extra to tender.

A thermocouple at the rear of the furnace is required and must be shielded from radiation. (MBB to quote.)

The ceramic materials to be used by NRC in their atomizer will be silicon nitride to start with zirconium and alumina combinations possibly tried later. NRC will also analyze the atomizer for strength of materials if the outer tube were removed.

Flame scanners (main and ignitor) will be supplied by Bailey, including mounting hardware. However, Bailey will require drawings of burner side section and back plate when available. MBB to supply from CAD drawings as soon as available.

Submitted by Allyn Todd
Allyn Todd

AT:mlm
1987-12-10

c.c. - Attendees
Mr. A. White
Mr. Joel MacLean
Mr. P. Zwicker

PROCESS
JAN 22 1988
TECHNOLOGY

MINUTES OF MEETING

TECHNICAL STEERING COMMITTEE

Date: 1988-01-15

Place: MBP&P Offices

Time: 09:00 hrs.

Attendees:

Kelly Thambimuthu	Canmet
Adam Bennett	NRC
David Lawrence	MBB Mechanical
Peter Zwicker	MBP&P
Gordon Brenton	MBP&P
Robert Kazmel	CBDC
Joel MacLean	CBDC

AM

The process drawings for the MBP&P coal-water fuel fired boiler, along with start-up and operating procedures were reviewed. As a result of the review, the following changes have been incorporated into the operating procedures:

1. Ensure, before starting fans, that both forced draft and induced draft manual dampers are open.
2. When first starting boiler, fill with 100° F water, rather than fully heated water.
3. Furnace pressure will be slightly negative.
4. For oil light-off, fifteen seconds will be allowed for establishing main flame before trip will occur.
5. When starting coal-water fuel burner, use water purge prior to light off, to wet lines.
6. Allow thirty seconds for coal-water fuel light off, to establish main flame before tripping.
7. When taking boiler out of service, bring coal-water fuel firing to minimum, then light auxiliary oil gun. Bring oil to minimum before isolating boiler. In this way, steam requirements will gradually be picked up by other boiler or boilers.
8. Logic for starting of the ID fan will be revised in order to ensure that before starting, both the FD fan must be running and the air low pressure switch must not be tripped.

9. Under Operating Data are the following revisions:

   a. atomizing steam/CWF ratio changed to .12 to .25 lb/lb
   b. exhaust oxygen level changed to 3 to 7%
   c. oil operating temperature changed to 200° F minimum
   d. oil exhaust oxygen level changed to 2 to 5%
   e. deaerator operating pressure changed to 20 psig
   f. separate section included for air heater.

PM

Piping layouts for the MBP&P and coal-water fuel fired boiler were reviewed and the following changes agreed upon:

1. A separate one inch steam line will be run to the boiler front to provide for the oil purge and a manual coal-water fuel purge. This line will not be dependent upon conditions on the atomizing steam lines.

2. Duplicate valve number VS106 on the chemical caustic line was changed to VS109.

3. Valves shown on the coal-water fuel strainers differential pressure gauge are not required and will be removed from drawing 360-5006-142.

4. A cover for the hatchways on the top of the coal-water fuel tanks will be constructed.

5. Piping for the water column on the deaerator tank must be routed towards back of tank because of location of catwalk.

6. A finalized process diagram will be provided by MBB Mechanical, showing all revisions. This will be either a revised CBDC drawing D06 or a composite of the approved piping layout drawings.

Attendees then toured both the new boiler installation site and the existing boiler house. Following the tour there was a short demonstration on how the CRT based operator interface unit would function and a brief discussion on the controls.

Minutes Taken By:

Joel MacLean
Plant Engineer
Coal-Water Fuel Plant
Cape Breton Development Corp.

INTRODUCTION

General

The Minas Basin Pulp & Power coal-water fuel fired boiler is a Babcock and Wilcox integral furnace type boiler, originally designed to produce 65,000 lb/hr of saturated steam, while burning light oil under forced draft conditions. Modifications were made to the boiler and its auxiliary equipment in order to accommodate the combustion of coal-water fuel and crude oil as replacement fuels to the light oil. Operating parameters for the modified boiler are as listed under Operating Data.

Basic operation of the boiler consists of the combustion of a correctly ratioed mixture of air and fuel in the combustion chamber; thereby, producing heat, which is transferred through convection and radiation to the boiler tubes. These tubes connect the boiler drum which sits on top of the combustion chamber, to a mud-drum below the combustion chamber. Steam is produced in the tubes closest to the combustion chamber, while the colder tubes towards the exhaust gas outlet act as down-comers. Natural circulation affects cause the steam to rise in the front tubes and water to flow downward in the rear tubes. Sufficient water level must be maintained in the drum, in order to provide the down-comers with a continuous supply ensuring not only that steam will be produced, but that no damage will occur through overheating of the tubes. The steam produced is then discharged, from the upper drum, through a non-return stop valve, into a boiler header.

Feedwater into the boiler drum is automatically controlled based on drum level and steam output. In addition, there are both low and high drum level safety switches which will shut down combustion if tripped. To prevent over pressure in the boiler drum, there are two pressure relief valves, one set for 175 psig and the other for 180 psig. These valves will open when the set pressure occurs and close again when the pressure drops below the set.

Both the upper and lower drum have blowdown lines. These are used to reduce settled solids concentrations in the boiler water.

Fuel and air input into the combustion chamber is automatically controlled based on steam pressure. When steam pressure begins to drop (i.e. steam demand increases), both fuel and airflows increase. When steam pressure starts to increase, both fuel and airflows decrease.

The furnace operates in a balanced draft mode, utilizing both an induced draft fan and a forced draft fan. The forced draft fan damper is used to control the flow of combustion air into the furnace. The induced draft fan damper controls the furnace pressure, which will normally be slightly positive or negative based on furnace performance.

Combustion air is preheated using a shell and tube type heat exchanger, where the exhaust furnace gas on the tubeside is used to heat the air on the shellside. In addition to preheating and control as outlined above, stack oxygen levels in the exhaust gas are continuously monitored and used to automatically trim the airflow.

The burner management automation is designed around state of the art equipment in order to provide for safe and efficient boiler operation under most conditions. The burner management system, not only provides for correct sequencing during start-up and shutdown, but also monitors various critical points in order to ensure safe conditions under normal operation. If a critical point, such as the boiler level goes into an alarm state, the burner management system will shutdown the boiler before damage should occur.

There are many monitored and/or controlled points on the boiler which include the following: steam header pressure, steam header flow, support steam flow, atomizing steam pressure, atomizing steam flow, drum level, deaerator level, furnace pressure, deaerator water flow, drum feedwater flow, chemical flow, oil flow, airflow, coal-water fuel flow, stack oxygen, burner temperature, combustion air temperature, exhaust temperature, ambient air temperature, heater outlet temperature. This monitored information will not only assist in the efficient operation of the boiler, but will provide valuable data on the combustion of coal-water fuel.

Utilization of Coal-Water Fuel

The combustion of coal-water fuel has, over the past years, proven to be a viable alternative to the utilization of heavy oil. Under normal ambient conditions above freezing, coal-water fuel has similar handling characteristics to those of heavy oil and actually has viscosities lower than that of heavy oil. The major advantages to using coal-water fuel are price and stability of supply. Other advantages include a lower toxicity then that of heavy oil and significantly reduced impact on the environment when spilled, as opposed to that of heavy oil. If stored beyond three months, coal-water fuel may require agitation or circulation in order to retain its properties. Coal-water fuel should be stored at temperatures above freezing.

OPERATING INSTRUCTIONS

Ensure the following valves are in positions as indicated.

Drum to blowdown - VS01, VS02 closed
Drum to level gauge - VS40, VS41 open
Drum level transmitter - VS42, VS43 open
Drum to sootblower - VS38 closed/VS39 open
Drum vent - VS27, VS28 open
Drum pressure indicator - valve open
Drum main header - VS29, VS31, VS81, VS83 closed/VS30 open
Deaerator steam regulation - VS09, VS10 closed/VS11, VS08 open
Deaerator vent valve - VS22 open
Deaerator waterfeed - VS05, VS06, VS55 closed/VS07 open
Deaerator level - VS24, VS25 open
Deaerator pressure - VS23 open
Deaerator to feedwater pumps - VS15 closed/VS17 (or VS16) open
Deaerator to drain - VS14 open
Deaerator to water return - VS19, closed/VS18, VS20, VS21 open
Chemical feed line - VS13, VS93, VS94 open/VS12 closed
Feedwater pumps to drum - VS32 (or VS33), VS35, VS37, VS104 open/VS36, VS34 closed
CWF atomizing steam - VS44, VS45, VS47, VS49, VS48, VS86 open/VS46 closed
Oil atomizing steam - VS101, VS103, VS108, VS89 open/VS102 closed
Propane supply - VS50, VS76 closed/VS51, VS85, VS52, VS97, VS53 open
Coal-water fuel supply - VS73 (and/or VS54), VS57, VS58-VS59 (or VS60-VS61) VS62 VS64, VS63, VS65 open/VS56 closed
Oil supply - VS80, VS66, VS68, VS79, VS69, VS84, VS99 open/VS67, VS106 closed
Windbox pressure - VS71 open
Flame scanners air purge - VS98 open
Pressure transmitter on furnace - VS70 open
Combustion air flow - valves on transmitter open, VS88, VS87 open
Muddrum - VS03 closed
Water to blowdown tank - VS04 closed
Blowdown drain - VS26 closed
Caustic chemical - VS106 open
FD and ID fan manual dampers open

Ensure that the following 460 V starters are in sequence:
Feedwater pump #1
Feedwater pump #2
Coal-water fuel control pump
Induced draft fan
Forced draft fan

Ensure that there is 120 V available to the following list of equipment:
Chemical metering pump relay.

Chemical tank agitator relay
Chemical mag flowmeter
Ignitor flame scanner
Main flame scanner
Ignitor
CWF magmeter
Oxygen analyzer
Bailey operator interface console
Bailey control cabinets
IBM computer
Chemical metering pump for caustic.

Placing Deaerator Into Service

1. Via operators console, place chemical controller in auto/cascade.
   - Adjust setpoint to aim.

2. Via operators console, place deaerator level control in auto.
   - Adjust setpoint to aim.

3. Slowly open VS83 allowing the boiler header (to VS29), and deaerator steam feed line to preheat.
   - After sufficient heating, valves VS29 and BS31 can be opened.
4. Using by-pass valve VS06 and VS55, allow deaerator to come to operating level.
   - manually adjust VS06 and Vs55 to get a water temperature between 80° F and 110° F.
   - if no condensate is available, then open VS10 while deaerator is filling and adjust to ensure a water temperature between 80° F and 110° F.

5. Follow procedure for filling boiler (Page 5).

6. Open VS05, close VS06 (by-pass), close VS10 (by-pass).

7. Slowly open VS09, allowing deaerator to begin heating.
   - While deaerator heats, observe the deaerator vent. As pressure builds in the vessel, there should be a noticeable plume of steam issuing from the vent.

8. When the deaerator is close to operating temperature, open VS55 about 25% (if condensate is available).
   - If no condensate is available, then open VS05 about 25%.

9. Allow deaerator come to normal operating level, then open VS05 to 100%.

- If VS55 is opened 100%, condensate will overflow into the drain.
- Normal operating level is 24 inches.

10. Adjust vent valve VS22 until there is a short plume of steam constantly issuing from the vent.
    - Too little throttling of this valve will waste steam, while over throttling will promote inefficient heating and deaeration

The deaerator should now be in full operation. For detailed instructions on operation and maintenance, refer to the Cochrane Uni-Pack Atomizing Deaerator booklet, later in this binder.

Filling Boiler

1. Via operators console, place drum level controller in auto.
    - Adjust setpoint to aim (normally 0")

2. Open VS15, allowing deaerated water to supply head to feedwater pumps.

3. Via operators console, start feedwater pump.
    - If VS16 is open then start feedwater pump #1; if VS17 is open then start feedwater pump #2.

4. While boiler is filling, ensure that the appropriate amount of chemical (caustic) is being added via connection inlet on boiler drum.

5. Allow boiler to come to operating level.

6. Return to Deaerator Start-up Procedure, Step 6.

Purging and Placing Ignitor Into Service

1. Operator should ensure that the boiler, furnace and other auxiliary equipment is functioning satisfactorily. In particular, it is imperative that operation of the control/burner management system is in satisfactory conditon.
    - Ensure dampers are OPEN

2. Via operator console, start FD fan.
    - If FD fan starts, permissive is granted to ID fan.

3. Via operator console, start ID fan.

4. Via operator console, place boiler in reset state.
    - If boiler will not reset, determine and correct problem.

5. Via operator console, start air purge
   - Length of purge should be established in order to ensure eight complete air changes in the furnace. Airflow should be at 70% of maximum.
   - When the purge is initiated both ID and FD dampers open to 100%, allowing maximum airflow.
   - Upon successful completion of air purge, permissive for propane ignitor will be granted.

6. Via operators console, place furnace pressure controller in auto.
   - Adjust setpoint to negative one inch pressure.

7. Via operator console, place combustion airflow in manual.
   - Adjust to minimum airflow.

8. Open propane isolation valve VS50.

9. Via operator console, start propane ignitor sequence.
   - The following sequence of events will occur:
     a. propane vent VA10 closes
     b. propane isolation valve VA11 opens
     c. propane to furnace valve VA09 opens
     d. ignitor energizes for five seconds.
   - If ignition fails, operator should determine reason for failure and correct problem. Furnace purge will be necessary before permissive is granted to retry the ignitor.
   - If ignition is successful, permissive is granted for main burner start.

For detailed operating and maintenance instructions on the FD and ID fans, the ignitor, the control system, etc., see the appropriate manuals.

Starting Main Burner

1. Via operator console, place oil flow controller in auto.
   - Adjust to minimum setpoint.

2. Via operator console, set fuel select switch to oil.

3. Via operator console, start main burner sequence.
   - the following sequence of events will occur:
     a. steam atomizing valve VA08 opens
     b. oil to furnace valve VA16 opens
     c. oil recirculation valve VA91 closes.
   - If ignition of main burner fails, operator should determine reason for failure and correct problem. If ignitor flame is still maintained it will not be necessary to re-purge furnace. When fail occurs,

valves go to their pre-ignition positions. Oil is allowed fifteen seconds to ignite before trip occurs.

4. When main flame is established, gradually increase oil and air firing while watching oxygen levels in the flue.
   - By adjusting airflow, oxygen percent should be maintained at slightly higher than normal operating levels.

5. When stable flame is established, the propane ignitor can either be stopped, via operators console or left on as a support to the main burner.
   - At anytime during normal firing, the propane ignitor can be utilized (if pemissives satisfied).
   - If not intending to use the propane, valve VS50 should be closed.

For detailed information on the operation and maintenance of the various pieces of equipment utilized in this procedure, refer to the appropriate manuals provided.

Placing Boiler On Line

1. Via operator console, place header pressure control on auto.
   - Set to 150 psig.

2. Via operator console, place oxygen controller on auto.
   - Set to 5%.

3. When boiler drum is emitting a regular plume of steam through vent, close VS27 and VS28.

4. When boiler pressure approaches operating setpoint (150 psig), switch air control and fuel control to auto/cascade.

5. Adjust air ratio control until oxygen level in stack is between 2% and 5%.

6. Set oxygen controller setpoint to 3%.

7. Monitor operation of boiler via operator console.
   - Boiler should be functioning in a steady state fashion with steam production increasing as demand increases.

Coal-Water Fuel Firing of Boiler

When boiler is producing a minimum 30,000 lb/hr of steam, coal-water fuel firing can be utilized:

1. Via operator console, start ignition sequence.
   - The following sequence of events will occur:

    a. propane vent VA10 closes
    b. propane isolation valve VA11 opens
    c. propane to furnace valve VA09 open
    d. ignitor energizes for five seconds.

2. Via operators console, place coal-water fuel controller on automatic.
    - set to minimum setpoint (2900 lb/hr.)

3. Via operators console, stop oil firing on main burner.
    - The following sequence of events should occur:
        a. oil recirculation valve VA91 opens
        b. oil to furnace valve VA16 closes
        c. oil purge valve VA78 opens
    - after fifteen seconds VA78 closes
    - main burner should now be stopped.

4. Via operator console, select coal-water fuel.

5. Via operator console, start main burner sequence.
    - The following sequence of events will occur:
        a. coal-water fuel to furnace valve VA15 opens
        b. purge valve VA13 opens
        c. after fifteen seconds valve VA13 closes
        d. coal-water fuel isolation valve VA17 opens
        e. coal-water feul pump starts
    - If ignition of main burner fails, operator should determine reason for failure and correct problem. If main burner ignition fails, the following sequence of events occurs:
        a. coal-water fuel pump shuts
        b. coal-water fuel isolation valve VA17 closes
        c. purge valve VA13 opens
        d. after fifteen seconds purge valve VA13 closes
        e. coal-water fuel furnace valve closes.

6. Upon successful ignition of the main burner, the coal-water fuel controller should be placed in auto/cascade.

7. Air should be placed in auto, and ratio adjusted to suit coal-water fuel.

8. Observe oxygen stack level and adjust air (via operators console), to obtain a reasonable level (4% to 7%).

9. The propane ignitor can be left to act as support to the burner or be shutdown.

Boiler should now be operating satisfactorily on coal-water fuel. For detailed information on the operation and maintenance of the various pieces of equipment utilized in this procedure, refer to the appropriate manuals provided.

Sootblowing

Sootblowing should only be carried out under stable conditions, when the boiler is operating at loads above 35,000 lb/hr. This is necessary to ensure against blackout.

For detailed instructions on sootblowing, reference the instruction manual for the Diamond model G9B Sootblower.

Shutdown Procedure

1. Place coal-water fuel control on manual and gradually reduce firing rate to minimum (2900 lb/hr).

2. Via operator console, stop main burner firing.
   - The following sequence should occur:
     a. coal-water fuel pump stops
     b. isolation valve VA17 closes
     c. purge valve VA13 opens
     d. after ten seconds purge valve VA13 closes
     e. furnace valve VA15 closes
     f. drain valve VA14 opens.

3. Via operator console select oil using CWF/oil select switch.

4. Via operator console start main burner on oil (maximum firing), and gradually reduce to minimum firing.
   - ensure that oil controller is in auto, but not cascaded.

5. Via operator console stop main burner.

6. Via operator console stop ignitor.

7. Slowly close VS29.

8. Close VS50, VS32, VS57, VS69 and VS31.
   - These valves will isolate the various fuel supplies and the boiler drum.

9. Via operators console start purge sequence.

10. Upon completion of purge stop ID fan.

11. Stop FD fan (via operators console).

12. Via operators console stop feedwater pumps.

13. Close deaerator to feedpumps valve VA15.

14. Open water drain valve VS34.

15. Close condensate valve VS55.

16. Close steam to deaerator valve VS09.

17. Close water to deaerator valve VS05.

18. Open drain on chemical valve VS12.

19. Via operators console, stop metering pump.

20. Isolate chemical tank using valve VS93.

21. Open drain on header valve VS81.

22. Open drain on coal-water fuel valve VS56.

If boiler is to remain inactive for any length of time, proper storage procedures should be followed. A water line should be connected to the coal-water fuel quick connect coupling and the lines completely purged out. The oil lines should be closed and purged. All steam and water lines should be drained.

__Wet Storage__

Boilers kept in wet storage may be put into service with minimum notice, drain water from the boiler until normal start-up levels are attained and the boiler is ready for start-up.

No unit should be wet stored if there is any possibility of the ambient temperature dropping below the freezing point of water. Deaerated demineralized water treated with ammonia to a concentration of 10 ppm and hydrazine to a concentration of 500 ppm should be used to fill the boiler through the regular feedwater connection until water appears at the steam drum vent. When deaerated water is not available, deaeration may be obtained by steaming the boiler after filling. After the unit is completely filled with treated water, close the vents and connect a five pound supply of nitrogen to the vents to prevent air from entering the system. In some cases, an expansion tank or surge tank above the drum elevation may be required to accommodate volume charges due to temperature changes. The ammonia and hydrazine are not required for short periods of storage of less than two weeks however, the nitrogen blanket is recommended along with sodium sulfite to prevent oxygen corrosion. Approximately eight ppm sodium sulfite is required to remove one ppm of oxygen.

Boilers can be kept in wet storage for years without corrosion if they remain flooded with the recommended chemical concentrations and the nitrogen blanket. It is recommended, however, that the boiler be drained every six months for an internal inspection.

Dry Storage

Boilers kept in dry storage must be completely dry. After the water side has been cleaned of deposits and filled with treated water, it should be fired until the pressure is at least 50 psi to be sure that all components are hot. Reduce the pressure the drain at approximately five psi. all drains and vent, including water column and gage glass drains, must be open during the draining period. Any water remaining will be evaporated by the stored heat in the boiler metal.

The remaining vapor must be removed by purging the nitrogen, or by removing the drum manhole covers letting air circulate through the boiler. When the unit has cooled, place trays of non-corrosive desiccant in the steam drum and close all manhole cover plates and vents and rains. The dessicant should be inspected every three months and replaced as necessary. In addition, the air inside the boiler should be displaced with nitrogen and a positive nitrogen pressure maintained on the boiler throughout the storage period.

Operating Data

Steam Data

Drum steam pressure - 160 psig
Header steam pressure - 150 psig
Header steam temperature - 360° F.
Header steam heat valve - 860 Btu/lb
Maximum steam production - 65,000 lb/hr.

Coal-Water Fuel Data

Coal-water fuel operating pressure - 70 to 120 psig
Coal-water fuel operating temperature - ambient (above freezing)
Coal-water fuel heat value - 10,250 Btu/lb
Atomizing steam/coal-water fuel differential pressure - 20 to 30 psig
Atomizing steam/coal-water fuel flow ratio - .12 to .25 lb/lb
Air/coal-water fuel flow ratio - 10 lb/lb
coal-water fuel exhaust oxygen level - 3 to 7%
Coal-water fuel burner minimum firing rate - 2900 lb/hr
Coal-water fuel burner maximum firing rate - 6800 lb/hr.

Oil Data

Oil operating pressure - 70 to 120 psig
Oil operating temperature - 200° F minimum
Oil heat value - 18,450 Btu/lb
Atomizing steam/oil differential pressure - 15 to 25 psid
Atomizing steam/oil flow ratio - .10 to .20 lb/lb

Air/oil flow ratio - 15 lb/lb
Oil exhaust oxygen level - 2 to 5%
Oil burner minimum firing rate - 200 lb/hr
Oil burner maximum firing rate - 1600 lb/hr.

Boiler Data

Original manufacturer - Babcock and Wilcox
Boiler type - package, integral furnace, membrane wall
Boiler dry weight - approx. 78,000 lb
Design pressure - 250 psig
Heating surface of boiler - 3,400 ft^2
Heating surface of furnace - 670 ft^2
Furnace volume - approx. 1400 ft^3

Air Heater

Boiler exhaust gas temperature - 600° F
Combustion air temperature - 400° F (on coal-water fuel)
Exhaust to stack temperature - 350° F minimum

Miscellaneous Data

Propane ignitor size - 5Mbtu/hr
Drum operating level - 0" water
Drum maximum solids concentration - 3500 ppm
Aim feedwater temperature - 210° F
Required feedwater pressure at boiler drum - 165 psig
Deaerator operating pressure - 20 psig
Windbox pressure - 5" to 10" H_2O
Furnace pressure - -2" to 2" H_2O
Efficiency under normal operating conditions - 75 to 85%.

Transmitters/Flow Elements

Gas Pressure Transmitters

1. Steam header pressure
   Calibration: 0-200 PSIG
   Model: Taylor Model 524T

2. Atomizing steam pressure
   Calibration: 0-150 PSIG
   Model: Taylor Model 524T

Differential Pressure Transmitters

1. Drum level
   Calibration: 0-27 in. water
   Model: Taylor 505T

2. Deaerator level
   Calibration: 0-48 in. water
   Model: Taylor Model 505T

3. Furnace pressure
   Calibration: -10 to +20 in. water
   Model: Taylor Model 505T

4. Oil flow
   Calibration: 0 to 89.74"
   Model: Taylor Model 505T

5. Combustion air flow
   Calibration: 0-2 in. water
   Model: Rosemount 1151 DR

Flow Elements/Flow Transmitters

1. Oil flow element
   Calibration: For 6000 lb/hr
   Model: Taylor Wedge Flow Element 1335L
   Size: 1"

2. Air flow element
   Calibration: For 0-85 k-lb/hr
   Model: Taylor Flobar Element 1350L
   Size: 36"

3. Coal-water fuel flow
   Calibration: 0-8500 lb/hr
   Model: Fisher Magnetic Meter
   Size: 1 1/2"

4. Chemical flow
Calibration: 0-100 lb/hr
Model: Fisher Magnetic Meter Model DJ104
Size: 1/4"

5. Deaerator water flow
Calibration: 0-75 k-lb/hr
Model: Fisher Vortex Meter DV 2001
Size: 2"

6. Feedwater flow
Calibration: 0-65 k-lb/hr
Model: Fisher Vortex Meter DV 2001
Size: 2"

7. Support steam flow
Calibration: 0-5000 lb/hr
Model: Fisher Vortex Meter DV 2001
Size: 2"

8. Header steam flow
Calibration: 0-65 k-lb/hr
Model: Fisher vortex Meter DV 2001
Size: 6"

9. Atomizing steam flow
Calibration: 0-2000 lb/hr
Model: Fisher Vortex Meter DV 2001
Size: 2"

Temperature Transmitters

1. Combustion air temperature
Calibration: 50-550° F
Model: Ris Temperature Transmitter SC-4326

2. Ambient air temperature
Calibration: 0-150° F
Model: Ris Transmitter SC-4326

3. Furnace exhaust temperature
Calibration: 100-700° F
Model: Ris Transmitter SC-4326

4. Heater exhaust temperature
Calibration: 100-600° F
Model: Ris Transmitter SC-4326

5. Burner temperature
Calibration: 50-450° F
Model: Ris Transmitter SC-4326

Oxygen Analyzer

1. Exhaust gas O_2 analyzer
   Calibration: 0-10%
   Model: Bailey OL110

Auto. 2 Position Valves

1. Deaerator to drain valve
   Tag: VA05
   Type/Actuator: Tomoe Butterfly/Automax
   Size: 3"

2. Steam header to burner
   Tag: VA08
   Type/Actuator: MCF Ball/Automax
   Size: 1 1/4"

3. CWF or pump discharge
   Tag: VA17
   Type/Actuator: Tomoe Butterfly/Automax
   Size: 3"

4. CWF purge valve
   Tag: VA13
   Type/Actuator: MCF Ball/Automax
   Size: 1"

5. CWF sump valve
   Tag: VA14
   Type/Actuator: MCF Ball/Automax
   Size: 1 1/2"

6. CWF to burner valve
   Tag: VA15
   Type/Actuator: MCF Ball/Automax
   Size: 1 1/2"

7. Oil to burner valve
   Tag: VA16
   Type/Actuator: MCF Ball/Automax
   Size: 1"

8. Oil isolation valve
   Tag: VA17
   Type/Actuator: MCF Ball/Automax
   Size: 1"

9. Oil recirculation valve
   Tag: VA18
   Type/Actuator: MCG Ball/Automax
   Size: 1"

10. Propane isolation valve
    Tag: VA09
    Type: ASCO solenoid
    Size: 1 1/4"

11. Propane to vent valve
    Tag: VA14
    Type: ASCO solenoid
    Size: 1 1/4"

12. Propane to furnace valve
    Tag: VA11
    Type: ASCO solenoid
    Size: 1 1/4"

Control Valves

1. Boiler feedwater flow
   Tag: VC04
   Type: Cashco QCT
   Size: 2", C_v = .4

2. Water recirculation flow
   Tag: VC03
   Type: Cashco QCT
   Size: 1 1/2", C_v = .4

3. Deaerator feedwater flow
   Tag: VC01
   Type: Casco QCT
   Size: 1 1/2", (full port)

4. Oil flow
   Tag: VC08
   Type: Cashco 964
   Size: 3/4", (full port)

5. Steam to burner flow
   Tag: VC07
   Type: Cashco 964
   Size: 1", (full port)

MINUTES OF MEETING

Technical Sub-Committee of the Minas Basin Pulp & Power CWF Conversion Steering Committee

February 9 and 10, 1988

Submitted by

Allyn Todd, P.Eng.

Technical Sub-Committee Meeting at MBB Mechanical
February 9, 1988

Location: MBB Mechanical Services Ltd., Halifax
Date: February 9/88 - 9:00 a.m.

Attendees:		
	Gordon Brenton	MBPP
	Dave Lawrence	MBB
	Kelly Thambimuthu	CANMET
	Adam Bennett	NRCC
	Bob Kazmel	CBDC
	Allyn Todd	CBDC

Minutes of Meeting

The group visited MBB shops at Five Island Lake to inspect the burner being modified for the Minas Basin Pulp & Power conversion.

Due to the unavailability of a meeting room, the group proceeded to NRC offices in their Atlantic Research Lab facility on Oxford Street. A list of deficiencies identified as a result of the inspection of the burner was drawn up and is presented as follows:

1. The ignitor guide tube requires fitting to the face plate.
2. Realignment of the guide tube support pipe is required to eliminate binding when adjusting primary air swirler assembly insertion depth. High temperature grease should also be employed.
3. Two remaining spider legs on the burner guide tube must be removed.
4. "OPEN " and reference numbers need to be stamped on the T-handles for primary and secondary air dampers.
5. New locating marks and numbers are needed on the burner guide tube allowing a ± 4 inch indication from the zero point.
6. New packing must be installed on the primary air damper.
7. Insulation (Mill-Board type) is to be installed on the inside surfce of the face plate with holes cut through to match holes in the face plate. Viewport tubes through the insulation are to be installed.
8. Centering ramps in burner guide tube are to be removed.

9. Burner guide tube must be cut to proper length, a critical dimension for NRC to use in determining atomizer length.

10. Main flame scanner tube to be built in through the refractory (external to the burner) to serve as a back-up in the event the location viewing through the primary swirler is not suitable.

11. A T-Handle is required on the auxiliary oil atomizer clamp for quick release capability.

12. The auxiliary oil gun guide tube is to be cut off short of entry into the necked down section of the primary air can.

13. A vane (removable) is needed for placement in the auxiliary oil gun support tube in the swirler for use when the oil gun is removed.

14. The auxiliary oil atomizer tip is to extend one inch beyond the swirler with capability of up to six inches further insertion.

15. The main oil atomizer Y-Jet tip is to be made at a 70° spray angle. This atomizer has not been fabricated yet.

The minutes of the November 28, 1987 Technical Sub-Committee meeting were reviewed and the following points noted:

A) Flex line requirements for commissioning were revised. Instead of quick disconnect lines, flex lines will be plumbed permanently in place. Two lines, 1 inch ID x 3 ft. long, stainless steel braided flex lines with 1 inch MPT fittings on both ends are required. MBP&P will supply, not CANMET as previously agreed.

B) Negative boiler pressure eliminates the need for air sealing between atomizer and burner guide tube.

C) Refractory must be kept from freezing prior to installation. Refractory will be of 80% alumina content and a fibreboard of expanded fibre-fill (ordered from B&W) will be on site in the event tube wall shielding is required.

D) Viewports are on site now for the rear and side of the boiler. Sealing air and a view damper are also provided.

E) MBB will quote on a thermocouple to be installed at rear of boiler to measure gas temperature. Shielding will not be required. Radiation error is expected to be 100-150°F.

F) Drawings are not required by Bailey in order to supply flame scanner mounting hardware. MBB will ensure that the scanners are properly mounted on the burner.

During the afternoon session, the CANMET burner drawings, drawn by MBB using AutoCad, were checked for proper detail and changes required for the MECL 5 burner test scheduled for this summer. The following major points were noted:

1. The primary air can divergent section is to be deleted and the design will only incorporate the straight section.

2. Primary air swirl vanes shall be reversed from position shown so as to impart CCW swirl.

3. For MECL the 14½" swirler drawings will be included but only the 13½" will be fabricated.

4. The secondary air damper pointers will be modified to point close to the scale so as to minimize parallax error.

5. The secondary air wall support bars will be relocated as per original drawing to allow full 360° rotation of vanes. Scales to remain as is with 0° = fully open.

6. Primary and secondary air damper pointers to be deleted and the end of the nipple through which the rod goes will become the datum point. Reference notches in rod will require relocating.

7. The auxiliary oil gun hole in burner plate and in primary swirler is not required for MECL.

8. Ignitor position at 10:00 is o.k.

9. The swirler carrier tube will be shortened to reflect the new length as per drawings.

A final review of modified drawings will be required. This is scheduled for February 24/88, 1:00 p.m. at MBB Mechanical offices. MBB agreed to send the modified drawings to CANMET (for preview) by courier on February 19/88.

On Wednesday, February 10/88, the group (except Gordon Brenton) returned to the MBB shop to obtain the new burner guide tube length✓ from which NRC will determine atomizer length. This was followed by a visit to Minas Basin Pulp and Power to observe

58½" incl swirler

progress. An inspection of the boiler furnace enabled location of the tube which will be bent for viewport access and approximate location of the flame scanner sight tube.

Submitted by Allyn Todd
Allyn Todd

1988-02-23

AT:mlm

c.c. - Attendees
Mr. A. White
Mr. L. MacNeil, NSDME
Mr. J. MacLean

MINUTES

Technical Sub-Committee of the Technical Steering Committee for the Minas Basin Pulp & Power Coal-Water Fuel Conversion Project

Date: May 30, 1988 - 4:30 p.m. - 9:00 p.m.
Place: Minas Basin Pulp & Power, Hantsport, N.S.

Attendees:
Gordon Brenton - MBP&P
Bob Kazmel - CBDC
Allyn Todd - CBDC
Adam Bennett - NRCC
Kelly Thambimuthu - CANMET
Dave Burnett - MBB
Dave Lawrence - Lawrence Engineering

Minutes

The boiler inspection of earlier in the day was reviewed. Ash accumulations were not considered severe either in the furnace or generating tube bank. Most ash retrieved from these areas was light brown in color and appeared to contain virtually no carbon. A thin (1/2" to 3/4") layer of slag covered the furnace floor for the first ten feet beyond which a crusty, easily broken material appeared, giving way to the light brown ash about 6 inches in depth at the rear wall. Ash caught at the boiler exit may have been trapped by a slightly protruding lip in the ductwork at that point. There were no signs of erosion.

The refractory quarl showed signs of both impingement of coal particles and oxidation. In particular, a circular concave depression in the refractory was observed. It measured 7/8" deep, 8 to 10 inches across and was located at about the 2:00 position in the quarl. Slag (1/2 - 3/4 inches thick) coated the frontwall of the boiler below the burner throat extending down to the floor.

Samples of ash were taken from various places in the boiler. The second inner row of screen tubes were observed to have acquired a growth of ash whiskers, easily removed and again, pictures and samples were taken.

It was decided that floor slag would remain but the lighter and more easily removed ash could be removed. One bbl. of material was removed.

Better viewports were suggested: an improved rear one and a port sighting along the mud drum. Also, a second sootblower was discussed. MBB were asked to quote on these items.

The decision was taken to burn a further 1000 t of fuel before the next inspection, estimated to probably be 8 weeks time.

A deficiency list of items requiring completion on the boiler was compiled, a copy of which is attached.

The fuel strainers (3 and 4 foot baskets) proved a maintenance intensive item and have successfully been replaced by a smaller screen element with 1/8" holes. The requirement for cleaning out the strainers subsequently dropped from twice per day and one hour per cleaning to once every two days and 20 minutes per cleaning. An in-line CWF strainer has been ordered as of May 27 with 4 - 6 week delivery.

NRC will provide a high shear in-line mixer, previously used with good success in their labs in Ottawa, for breakup of agglomerated or flaked material which may be the origin of pebbly looking dried coal agglomerates forming or catching at the screen. No atomizer blockage has been observed with the new screen in use.

It was suggested that problems encountered with purging could be better controlled with a larger negative furnace pressure and/or repiping the oil feed line to allow a manual bleed-off purge. Also, additional water purge may be required on the CWF line (the last 3 to 4 feet).

Operating the furnace at negative 1/2" pressure should be possible to avoid excessive inleakage of tramp air.

A presentation on combustion aerodynamics and tertiary port firing was made by Kelly Thambimuthu. This gave rise to a lengthy and occasionally heated discussion on modifications to windbox and/or air register.

As a result, several items evolved including an action plan. In order to prevent the phenomena of an uneven combustion air pressure distribution occurring within the windbox, which currently appears to be the case, expanded metal could be installed inside the windbox and positioned so as to break up the existing air flow patterns. The decision was taken to order or have available on short notice the appropriate materials.

Availability of a 14-1/2" dia. primary swirler will be reported by Dave Burnett.

Estimates received to date for an ash removal system on the air heater hopper range from $2,200 to $24,000. Since the ash collected measures approximately 40% ash, the remainder is likely combustible and might be disposed of most efficiently in the wood boiler. A test will be conducted to evaluate this disposal method.

Ash characterization study work planned was reviewed briefly and proposed erosion study work was discussed. Erosion studies might be best conducted by replacing screen tubes with control sample tubes for the two year period. Several groups would be capable of such work.

The new gas ignitor (5 MMBtu/hr.) is on site and all necessary matchup parts have been fabricated and are available for installation and hook-up.

The NRCC atomizer has performed extremely well on both oil and CWF. 256 hours have been logged on CWF to date. 161 of those hours have been on the 60° Alumina/10% Zirconium ceramic and 95 hours have been logged on the 70° Alumina ceramic. A larger degree of wear has been observed on the 70° tip than on the 60° cone. It is estimated that the 70° tip will last for only an additional 5 to 25 hours on CWF. NRC agreed to provide two additional 70° tips. CANMET agreed to provide any additional funding required for ceramic work through an existing CANMET program with NRC.

The following action plan was developed for approval by the Steering Committee:

	Action Item	Responsible Party
1.	Order expanded metal for windbox if long lead time is required	A. Todd
2.	Remedy the deaerator steam pressure control problem	G. Brenton
3.	Repair or replace the feedwater flowmeter	G. Brenton
4.	Calibrate the O_2 analyzer	G. Brenton
5.	Provide 2 x 70° ceramic tip sets	A. Bennett
6.	Test various boiler operating parameters over a one week period and evaluate further action required.	K. Thambimuthu A. Todd

Item #6 on the action plan is tentatively proposed for the week of June 20 depending on the availability of personnel and equipment. If approval can be obtained by K. Thambimuthu, he will have two technicians bring equipment down from Ottawa to do gas testing for NO_x etc. and to do further air studies and optimization on HFO and CWF.

Following this testing, evaluation of further action will take place by the Technical Sub-committee, if necessary.

A problem plaguing the project all during commissioning has been the plant's ability to use all of the steam #7 boiler can generate. Line losses to the #5 boiler house were too large to permit #7 to carry full load. This problem has been relieved, at least in part, by the removal of a bottleneck in the steam delivery line. As of May 27, boiler #7 has been able to supply 51,000 lb./hr. of steam to #5 boiler house and run the mill with #5 shut down for 20 - 30 minutes. Excessive load swings in steaming rate on #7 prevented a longer test period, due to lack of proper control on feedwater flowrate and temperature (Items 2 and 3 on the action plan).

The action plan outlined above will be presented to the project steering committee tomorrow.

Attached is the daily operations summary for May 27, 1988.

Respectively submitted

Allyn Todd

Allyn Todd, P.Eng.
1988-06-15
AT:mlm

Distribution

Attendees
Lorne MacNeil
Adrian White

1988-05-31

BOILER #7 - ITEMS FOR COMPLETION

Pipefitters

Remove and replace feedwater flowmeter.
Remove and replace deaerator steam control valve and regulator.

Instrumentation

Install O_2 gas, regulators and calibrate analyzer.
Tune O_2 trim controller.
Repair or replace feedwater flowmeter and retune controllers.
Prepare OIU for audible alarm cancel and connect alarm to PCL.
Repair sticking CWF - PSID gauge.
Repair CWF atomization steam control line (refill?)
Tune oil & CWF flow controllers for Cascade operation.

Electrical

Install audible alarm on boiler trip.
Install ceiling fan circuit.
Raise power cable to ID fan off ground and off steamline.
Install propane "ON" light on boiler front.

Safety

Install additional lighting at rear of boiler #7.
Install improved stepladder at rear of boiler #7.
Audible alarm required for boiler trip.
Halon extinguisher system required for Control Room with temperature indication alarm to security.
Larger "No Smoking" signs/stickers required for Control Room.

General

*Solve deaeration control problem.
*Solve steam line problem.
Ship bbl's of fly ash to CBDC.
Install screen on manual outdoor FD damper.
Obtain nipple reducers and caps for 4" tertiary air ports. (On order.)
Grout sway pipes on stack.
Install ceiling fan (ordered).
Install sample port and temperature indicator on feedwater line from deaerator.
Install new ignitor.
Reroute air steam heater steam trap discharge away from heater footings.

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                   MINAS BASIN PULP & POWER CWF FIRED BOILER
                   -----------------------------------------                1988
                             DAILY OPERATIONS SUMMARY          MONTH           5
                             ------------------------            DAY          27


COMBUSTION                      MINIMUM    MAXIMUM    AVERAGE      TOTAL  BTU TOT.
----------                      -------    -------    -------      -----  --------
COAL/WATER FUEL (LB/HR)              -2       6382       2644      63397    665674
OIL (LB/HR)                           0          0          0          0         0
AIR (K-LB/HR)                         0          0          0          0    N.A.
ATOMIZING STEAM (LB/HR)               1       1153        735      17617    N.A.
OXYGEN (%)                            2          9          5    N.A.       N.A.


AIR HEAT                        MINIMUM    MAXIMUM    AVERAGE
--------                        -------    -------    -------
COMBUSTION AIR TEMP. (F)            140        331        261
AMBIENT AIR TEMP. (F)                79        108         93
EXHAUST GAS TEMP. (F)               268        581        438
HEATER EXHAUST TEMP. (F)            188        438        341



STEAM/WATER                     MINIMUM    MAXIMUM    AVERAGE      TOTAL  BTU TOT.
-----------                     -------    -------    -------      -----  --------
STEAM PRODUCED (K-LB/HR)              0         51         25        590    589885
STEAM PRESSURE (LB)                 145        165        152    N.A.       N.A.
DRUM LEVEL (IN)                      -3          7          1    N.A.       N.A.



AUXILIARY                       MINIMUM    MAXIMUM    AVERAGE      TOTAL
---------                       -------    -------    -------      -----
SUPPORT STEAM FLOW (LB/HR)            0       2657       2037      48848
CHEMICAL FLOW (LB/HR)                 0         36          6        151

FURNACE PRESSURE (IN.)               -5          4         -1    N.A.
ATOM.STEAM PRESSURE (LB)             -3        151         87          0


        BTU'S IN       665674   NET STEAM OUT         523420
        BTU'S OUT      589885                              0
        EFFICIENCY         89                              0
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MBP&P CWF Project
Technical Sub-committee Meeting
August 15-16, 1988

NRC-ARL, Oxford St.
Halifax, N.S.

PROCESS
AUG 29 1988
TECHNOLOGY

Minutes of Meeting

Attendees

Bob Kazmel - CBDC (Chairman)
Gordon Brenton - MBP&P
Kelly Thambimuthu - Canmet
Allyn Todd - CBDC
Dave Burnett - MBB
Adam Bennett - NRC
Greg Landry - CBDC
Dave Lawrence - Lawrence Engineering (Aug. 16)

August 15

1. Review of Minutes from meeting of 1988-05-30

Allyn reviewed the items from these minutes. The nature of the flyash was noted, and was considered as not serious. The fuel strainers were successfully replaced; the in-line mixer installation discussed at this meeting has since been installed and tested and its effect was considered positive. NRC have submitted a proposal for a new high shear mixer and CBDC will issue a P.O. The purging problem with the fuel line was readdressed; it was felt that the problem could be alleviated by: (1) replumbing with more direct lines, (2) relocating the automatic valve in the CWF line to a point closer to the flushing inlet, and (3) increasing the flushing water inlet pressure (the steam pressure was also felt to be interfering with purging but can not be eliminated). It was decided that action should be taken on the changes to improve purging. Allyn noted that the ash characterization study by NSRF has been approved and sampling/testing will begin by late September or early October; results should be available by November.

The new gas ignitor has been installed since the previous meeting, and is operating well. The action plan from the meeting was reviewed and all items have been taken care of. Steam problems related to line size problems are still under consideration by MBP&P. Gordon noted that there are problems in restarting on CWF after a short shutdown; it is necessary to change settings to restart. The problem is possibly related to fuel drying and could perhaps be reduced by increasing the fuel velocity. Adam illustrated a technique to achieve this with an insert into the fuel line of the gun reducing its cross-sectional area and thereby increasing the flow velocity. A few other problems from the past were noted, namely fuel drying in the storage tanks (should improve ventilation), Bailey PCW software and fuel/steam pressure differential (probably need a new steam regulating valve).

A few other items from these minutes were deferred to the appropriate area in the agenda.

2. Flyash disposal

The flyash disposal relates initially to flyash collected from the air heater, but must eventually address a flyash collection system for the flue gas stream. Proposals based on basic data from MECL and MBP&P were discussed. They represented several options, including three pneumatic systems (see attached summaries). Dave Burnett feels the simple wet venturi system (as used by Bowater-Mercey) is a safer type; pneumatic systems have problems with unburned carbon and sparks.

As far as ash collection is concerned, Dave also felt wet systems are safer. The Waterloo scrubber and other wet scrubbers are perhaps the best alternatives. The various dry systems (multicyclones, baghouses and electrostatic precipitators) each have some drawback, such as lower than acceptable efficiency or higher than acceptable cost. Nonetheless, it is felt that ash collection alternatives should be investigated before the results of the NSRF study are complete. It is also felt that an ash disposal system should be put in place as soon as possible because the problem at Minas is immediate. Although the wet disposal system (venturi airlock) is inexpensive and effective, there is the dewatering and effluent to deal with (CBDC has two screen units which can be considered for the dewatering). Examination of the system at B-M and evaluation of conditions at MBP&P over the next few days will help in the decision.

3. Boiler ash removal

The removal of ash from the boiler proper was discussed. Bob has previously received a quote from MBB on a clean-out door at the rear of the boiler (gas pass side) for $3,480.00, (copy attached). Clean-out requirements would also require a door at the back corner of the boiler to rake or vacuum ash. This opening would be approximately 14" x 16" and would allow for personnel access by cutting and welding tubes in the area. MBB will requote on this work to include all the items. The work will be scheduled for September.

4. Review of ceramics

A total of 13 atomizer tips have been supplied to MBP&P. Adam outlined some of the various tips, including two silicon nitride and the various alumina and alumina-zirconia at 70° or 60° angles. The longest burn was with the alumina - 10% zirconia at a 60° angle; the nozzle was dropped and broken. In order to better determine the life and problems with atomizer tips, the operators should keep track of them in their log book, noting any changes. Bob brought up the Canmet contract for ceramic work and mentioned his discussion with Williams & Wilson (Coors Ceramics); they are a large commercial ceramic company with expertise in materials and production. They have been informed of NRC's work and NRC has since had some contact with them.

Williams & Wilson's capabilities will be further pursued by NRC. Current thinking from work at NRC-ARL is that perhaps 35% Zirconia is required in the ceramics. Long-life (1000 hr) of the ceramics is the objective of the Canmet sponsored work; materials and production are to be investigated.

Adam also updated the meeting on the status of the high-shear mixer for MBP&P. The small unit presently in place will be removed and returned to NRC. It successfully demonstrated its function and although it was difficult to say absolutely that it made an improvement, it appeared to do so; it certainly did not cause any atomization/combustion problems. The new mixer will have double mechanical seals and will, therefore not have the leakage problems of the test unit. The seals represent the longest delivery time (Adam is awaiting further information on the seals). The cost of the mixer is $16,000.

August 16

5. EMR test results

Allyn first reviewed some of the operating results. In particular, he noted some results on oil firing; on Apr. 14 60.9 mm Btu/hr was achieved, but only for a matter of seconds and was not considered as very meaningful because it was from the time of the high windbox pressure (before tertiary air ports were drilled). Other results from May 12 (39.5 mm BTU/hr) and July 12 (36.5 mm BTU/hr were noted. The vanes on both the primary damper and the secondary damper are typically set wide open, and Bob questioned this (why are they needed?). Kelly said they are required for air ratioing if necessary, but they are normally wide open. Adam felt the oil flame was better with the secondary air cut back, and also that the burner burns CWF better than oil. Kelly again described the burner as essentially a CWF burner with oil burning capability.

Some results on CWF were discussed from the operating data. A high of 66.5 mm Btu/hr was reached on May 27 for 20-30 minutes (the windbox pressure was not recorded, but was probably 7"-9"- Dave Burnett said that one could expect say 6"-9" on a modern day oil burner at full load). The next highest firing rate was 52.7

mm Btu/hr on July 7 for about 1/2 hour, but the stack was dark (this was with the 14 1/2" can, installed on July 4). Gordon felt that high load operation has always been poor. No sustained high firing rates have been held because of plant conditions (not boiler problems), but other factors related to the burn would probably prevent such firing anyway.

Allyn and Kelly described the EMR emission testing. From July 6-14 the boiler burned mostly CWF and a total of almost 100 tonnes was used (about 50 tonnes of CWF was burned during the three days of actual testing, July 11, 12 and 13). However, problems were encountered beginning late on July 12; the flame would go bad and various steps were taken by way of purging, line flushing, mixer start-up, and so on, but the burn continued to falter. Tip plugging was suspected, but no actual blockage was ever noted according to Allyn. He and Kelly were quite puzzled by this turn of events and at the time of test end the boiler was burning oil. Nevertheless, the NOX results were encouraging to Kelly, with lower levels recorded than for other comparable tests.

Bob and Adam confirmed the operating condition on Monday, July 25; it would run OK for about 1 1/2 hours, then the flame would go bad, or even out. This condition was reported by MBP&P operators since the time the EMR tests were completed; some adjustments were made, but no sustained firing could be achieved. Bob and Adam noted that the gun was extremely hot when removed (oil bubbling and flashing). They decided to change back to the smaller (13 1/2") can and remove the lower half of the diffuser. This immediately allowed sustained firing - the boiler has run steady most of the time since the change. The main concern now is why such a difference was noted upon making these changes. Bob suspects the high temperature condition of the gun and something to do with it (fuel drying?). Kelly explained that the recirculation pattern with the larger can will in fact result in a hotter zone close to the atomizer. The same fuel was burned after the change as before and there were no problems, so the fuel was felt to not be directly responsible for the poor firing with the larger can.

Bob mentioned at this time his concerns over: (1) complaints about fuel conditions without proper discussion with CBDC and, (2) communication with unauthorized personnel at MBP&P, both of which can be damaging to the overall project. All communication should be directed to CBDC management or to Gordon Brenton at MBP&P, as appropriate.

Discussion continued on the burner performance/capability. Dave Burnett stated that for conventional oil firing a 5:1 turndown can be expected; 2:1 is normal for pulverized coal firing (3:1 is exceptional). He suggested that for the range expectations of the #7 boiler two burners may be necessary; in this way the low load requirements would be met by firing one of the two burners.

Bob feels the existing range of the burner is 25-35 mm Btu/hr and Gordon confirmed this, noting that even oil firing above this range is poor. Dave Lawrence reminded the meeting that the decision last year was for oil firing below 30 mm Btu/hr (the burner was considered 30-55 mm Btu/hr on CWF). There is now the consideration of other applications for the burner (NSPC, MECL, etc.), and the need to ensure its development is in line with the overall CWF program.

The MBP&P and MECL applications were quite different. Dave Lawrence felt that the conditions/results at MECL misled people as to the Canmet burners capabilites; he did point out, and it was agreed unanimously, that the Canmet burner is a very good burner (certainly better than the Coen burner), but that it has a different range than initially thought.

Kelly felt the upper limit of the burner is higher than the 35 mm Btu/hr generally considered the present limit, and Allyn agreed; Allyn, however recognized the unsustained burn at any observed higher rates and felt this was a valid concern with respect to the burner's actual capability. Dave Burnett suggested "fixing" the boiler to allow sustained high loading by providing for steam venting; the questioning of whether or not the tertiary air ports should still be used was raised because they are unconventional.

The effect of this air is essential to the boiler operation at present. Kelly felt some benefit may be gained by using a 15 1/2" primary can if no tertiary air were available.

Dave Lawrence presented data showing the square inch opening of several burner types; the general situation is about 500 sq. in. for 55 mm Btu/hr (from extrapolation of a "generic" design). The 23" Coen burner at MECL is 425 sq. in. and was a nominal 55 mm Btu/hr. The 20" Canmet burner at MBP&P is only 314 sq. in; the 8 x 4" openings (tertiary ports) make a total of 415 sq. in. Dave suggested modifying the burner by increasing its diameter with the addition of a tertiary air sleeve. The concept was illustrated and it was decided to discuss it with the action plan.

6. Action Plan

The main course of action for the #7 boiler will be to carry out the "fix" to allow sustained firing at high load (say 60,000 lb/hr of steam on oil firing). Kelly felt this would be a problem because of the air ratioing - the register is essentially set up for CWF, and he suggested that the oil flame will be smokey at high rates with the 13 1/2" can. The general understanding of the meeting was that an attempt should be made to verify the boilers limits, and this "fix" represents the only practical approach. The importance of the extra air from the tertiary ports cannot be neglected and the modification providing for the tertiary air sleeve is considered a worthwhile attempt. The action plan was, therefore formulated as follows:

(1) modify the burner front to accommodate the tertiary air sleeve; the existing tertiary ports will be capped.

(2) install vent line (3"-4" line, muffler and steam vent valve).

(3) concurrently, modify one of the MECL burners to increase the secondary air inlet (extend blades) and secondary cone diameter; the modified burner can be used at MBP&P if necessary.

This action plan will give two possible alternatives to the present problem of inadequate range (upper limit). They are recognized as attempts only, but under the present operating conditions something must be done. If these attempts are not successful, then the boiler can be returned to the present conditions.

There were several other suggestions to go along with the action plan. Relocation of the camera to the rear of the boiler should be considered (instrument cabinet probably available from AECL). The stack should be monitored (O_2 monitor part due in mid-September - Allyn will pursue this after checking with Scott at MBP&P). Replacement of the flame scanners under warranty (expires after November) should be done. In order to undertake the action plan, MBB should submit a new quote to include the following:

(1) new 70% open area screen at the top of the windbox (widest part).

(2) modification of the burner throat and design, fabrication and installation of the new tertiary air sleeve.

(3) modifications to the MECL air register as previously described.

(4) drawings of the changes, including floppy disks.

(5) clean out doors as discussed yesterday.

(6) supply and installation of vent line.

MBB will submit this quote to CBDC as soon as it is complete. The tentative date to carry out the work will be the week of September 19. CBDC will investigate the availability of a muffler from AECL, but Dave will price a commercialially available one anyway. It was also decided to have NRC to provide further tips, including 60° and 70° ceramic tips and an 80° stainless steel tip; CBDC will place the order for these tips.

The meeting ended with a list of concerns drawn up by Gordon. Most of these had been addressed during the meeting. These items are listed on the attached page.

Minutes Prepared By: Greg Landry

Greg Landry
Plant Engineer
Process Technology
Coal-Water Fuel Plant

GL/kb

Attachments

c.c.: Attendees
A. White

1988-08-25

FLYASH DISPOSAL

SUPPLIER	SYSTEM	COST
PROMAT	pneumatic system, completely installed and automated as neccessary	$24,773
UNITRAK	mechanical (helix conveyor) flyash removal to disposal (23 ft)	$9,730
FULLER-TRAYLOR	Venturi Eductor and Regenerative Blower (piping and installation not included)	$2,642 +
SULLIVAN STRONG SCOTT	"dense-phase" pneumatic conveying with control panel (piping and installation not included)	$25,436 +
JOY	Wet Venturi Airlock (installation and dewatering not included)	$3,500 +

FLYASH COLLECTION

SUPPLIER	SYSTEM	COST
GERBER	2-75" cyclones (rotary airlock valves required in negative pressure applications--not included in price)	$9,116us +

MBB

M.B.B. Mechanical Services Limited

P.O. Box 39 Lakeside, Halifax Co. Nova Scotia B0J 1Z0
Phone (902) 876-8213 Telecopier (902) 876-8402 Telex 019-22793

DEVCO - COAL DIV.
ORIGINAL
JUN 21 1986
A
ACCOUNTS PAYABLE

June 14, 1986

CAPE BRETON DEVELOPMENT CORPORATION
P. O. Box 2500
Sydney, Nova Scotia
B1P 6K9

ATTENTION: R. Kazmel

Dear Bob:

REFERENCE: Minas Basin Pulp & Power Ltd.
CWF Demonstration
Wash Out Doors, Boiler Rear Wall
MBB 2-1852

We are pleased to quote for the supply and installation of two (2) insulated steel doors to be located in the rear, just above the mud drum, to assist in observation and clean out.

We quote as follows:

Material F.O.B. site, taxes extra	$1,070.00
Installation Labour	2,410.00

This price is valid for 30 days.

Yours truly,

MBB MECHANICAL SERVICES LIMITED

DJB

D. J. Burnett

DJB/sb

RECEIVED
JUN 21 1986
C. B. D. C.
C B CARBOFUEL

August 3, 1988

1. Should be able to produce maximum steam load on No.7 before winter heating load starts.
2. Should have small burner installed to maintain and hold steam load when changing over from C.W.F. to bunker.
3. Correct smoke problems with both fuels on high loads.
4. Fall out from stack, should be corrected as soon as possible.
5. Large build up of materials in furnace. problem should be looked at.

6 - Having Problems with Primary air dampers.

7 Problems with C.W.F. in fuel tanks. (Caking)

8 Problem with C.W.F. burner plugging on low load.

APPENDIX G

PROJECT EVENTS AND MILESTONES

APPENDIX G

Project Events and Milestones

The events of the project are presented here in diary form, from the introduction of CWF to MBP&P personnel in September, 1986 through to project status as of November, 1988.

G.1 Diary of Project Events to Completion of Commissioning (September, 1986 - April, 1988)

The following list, in diary form, comprises an outline of the project events from inception through to and including commissioning. Highlighted in bold print are the dates of project milestones which are also listed separately at the end of Section 5.1.

Date	Event
Sept. 15/86	Initial introduction of CWF to MBPP.
Nov. 14/86	Samples of CWF presented to SIL Board for display.
Nov. 20/86	CBDC initial project planning meeting.
Dec. 1/86	Major presentation to MBPP Management in Glace Bay, site visit to boiler and CWF plant.
Dec. 9/86	Initial meeting with CANMET in Glace Bay re funding.
Dec. 12/86	OSF funding secured.
Jan. 8/87	Senior management approval - CBDC.
Jan. 13/87	Site visit to MBPP & meet with management.
Jan. 19/87	CANMET in for $300K, OSF in for up to $370K (verbal committments.)
Jan. 29/87	Technical aspects being worked on and identified.
Feb. 4/87	Review & planning meeting, Glace Bay.
Feb. 5/87	Review & planning meeting, Glace Bay. Draft tender package tabled.
Feb. 20/87	Draft tender package review.

Feb. 23/87	CANMET & OSF funding confirmed. Tender package review.
Mar. 3/87	Tender package review.
Mar. 11/87	Tender calls sent out.
Apr. 6/87	Tender submission deadline.
Apr. 9/87	Meeting at NRC re atomizer for the project.
Apr. 22/87	Tender submission review. Meeting with D. Burnett to review budget proposal.
May 8/87	CBDC purchased boiler from AECL.
May 15/87	Boiler has to be removed immediately from location due to construction work on the building.
May 29/87	Negotiation meeting to review project.
June 5/87	Stack emissions testing proposal submission deadline.
June 8/87	Draft contract submitted to MBPP.
July 6/87	MBPP contract negotiation at MECL, PEI.
July 9/87	CANMET contract signed (300K).
July 22/87	DME contract signed (358K).
July 28/87	MBPP contract signed.
July 31/87	Tender awarded to MBB Mechanical.
Aug. 13/87	Steering Committee (SC) meeting #1.
Sept. 15/87	Technical Sub-committee (TSC) meeting #1.
Sept. 15/87	Stack arrived on site.

Sept. 23/87	Excavation on site begins.
Sept. 24/87	Boiler equipment arrived at Five Islands.
Sept. 30/87	SC meeting #2. First cost overruns tabled. Baghouse quotations tabled. Burner/atomizer description tabled.
Oct. 20/87	Pile driving completed. Piles ranged 39 - 74 feet.
Oct. 30/87	All foundation work completed.
Nov. 3/87	Stack base poured.
Nov. 5/87	Blowdown tank declared unfit.
Nov. 18/87	SC meeting #3.
Nov. 24/87	Boiler arrived on site.
Nov. 28/87	TSC meeting #2.
Nov. 30/87	Boiler and air heater placed on footings.
Jan. 6/88	SC meeting #4. Meeting with DOE at Hantsport.
Jan. 11/88	Boiler house weathertight and feedwater pump overhaul complete.
Jan. 13/88	Oil set installation complete and power on Bailey Network 90 OIU.
Jan. 15/88	TSC meeting #3.
Jan. 29/88	Balanced draft system installation complete.
Feb. 9, 10/88	TSC meeting #4. Final burner fabrication inspection and modifications.
Feb. 16/88	CANMET air register installed.

Feb. 24/88	Boiler pressure tested to 300 psi under supervision of Department of Labor.
Feb. 25/88	SC meeting #5.
Mar. 4/88	Blowdown tank installed. MBB work completed. Boiler inspection by DOL.
Mar. 6/88	Main steam header tested.
Mar. 7/88	5 x 40 gal. propane tanks installed. Insulation of air handling system complete.
Mar. 8/88	Bailey Network 90 PCU powered up.
Mar. 11/88	Deaerator commissioned.
Mar. 26/88	First HFO fire in boiler.
Mar. 28/88	- Manual atomization steam purge bypass installed. - Insulation being installed on lines. - Mounted main flame scanner on upper port. - Encountered foreign material in steam line - plugged steam side of atomizer. - Steam purge too large.
Mar. 29/88	- Set up steam purge limit. - Procured smaller auxiliary oil atomization tip. - Installed mirror for improved video viewing. - Problem with flame scanners (cables too short). - More foreign material in lines causing blockage.
Mar. 30/88	- Blew down steam line for 30 min. to clear foreign material. - Generated first steam in boiler at 3:13 p.m. on oil at about 13 MMBtu input, on auxiliary gun. - Oil flame impingement on boiler wall.

Apr. 4/88	- Inspected furnace interior. New refractory pulling away from old. - Labels stamped on air dampers. - Propane vent valve actuator overheating.
Apr. 5/88	- DOE granted conditional permit. - NRC arrived on site. - Railing on tank tops being installed. - Feedwater flow to drum meter requires repair. - Scanners rewired with new cable. - Foreign material caused blockage again.
Apr. 6/88	- Installed steam strainer & pressure gauge. - Mounted both scanners on upper port. - First shipment of CWF arrived on site (4 p.m.) - Propane vent valve malfunction. - Fuel offloading pump defective. - Propane delivery - 66 l.
Apr. 7/88	- NRC gun in. - #7 boiler carried the load while #6 down for repairs. 24000 lb./hr. - S.C. meeting #6.
Apr. 8/88	- Fisher valve rep repaired feedwater flow meter. - Hi drum level alarm trip jumpered. - Steaming from 11:15 to Sun. 7:30 a.m.
Apr. 9/88	- Boiler operated around the clock on oil.
Apr. 10/88	- Began flushing & preloading CWF system.
Apr. 11/88	- Inspection of furnace interior - packed Kawool in separation between old refractory and new refractory quarl. - Attempted first firing of CWF. Ignitor not large enough. Poor unstable combustion. Atomization appears good. Returned to oil firing.

Apr. 12/88	- Low steam demand due to board mill being down; unable to switch to CWF. - 8:45 p.m. - Began firing CWF and optimizing flame. - Achieved 35000 lb./hr. steam on CWF. - 12:00 p.m.- Boiler trip and operators unable to restart on CWF.
Apr. 13/88	- 2:00 p.m. - Installed atomization steam strainer. - 3:20 p.m. - CWF rupture disk failure. - 7:45 p.m. - Switched successfully and smoothly from HFO to CWF without changing atomizers. - 8:55 p.m. - Boiler trip on low scanner air pressure. - 10:15 p.m.- Switched from HFO to CWF, smoothly. - 11:30 p.m.- Rupture disk failure, returned to oil firing. - 12:30 p.m.- Problems with #6 boiler. Must keep #7 up on oil.
Apr. 14/88	- 9:30 a.m. - Smooth switch to CWF. - 2.55 p.m. - Rupture disk failure. Returned to oil firing. - 6:00 p.m. - Boiler trip on propane pressure low. Ignitor had been left on. - 7:00 p.m. - Shutdown to change atomizers and replace ruptured quick connect gasket. - 8:00 p.m. - Feedwater flow control problem to drum identified. - 11:56 p.m.- Using backup oil pump, achieved 50,000 lb./hr. steam on oil.

Apr. 15/88 - 8:30 p.m. - Meeting with P. Zwicker and G. Brenton to review items requiring completion.

- 1:00 p.m. - Cleaned CWF strainer #1. 2 inch layer of partially dewatered CWF caked on inside of screen.

- 3:00 p.m. - Boiler to stay on oil until Saturday when board mill will be down for scheduled maintenance Saturday thru Monday.

- Tremendous heat on top of fuel tanks due to no ceiling vent.

Apr. 20/88 - 3:30 p.m. - Meeting with Gordon Brenton re items requiring completion. No work accomplished since CBDC last on site on Apr. 15. Reason - all manpower removed from CWF project to work on MBP&P plant project.

- Investigated deaerator steam control problem.

Apr. 21/88 - 8:30 a.m. - Meeting with P. Zwicker and G. Brenton re getting some manpower. Only personnel available are electricians who must wait for materials to arrive.

- Lindsay is in to inspect for ceiling vent/fan requirement.

Apr. 22/88	- 8:30 a.m. -	Boiler drum level low trip test. Problems with PCU discovered. Difficulty getting instrumentation personnel.
	- 10:45 a.m.-	Jeff Tracey assigned to repair PCU.
	- 2:50 p.m.-	PCU repaired. Modifications to CWF screen housing completed.
Apr. 25/88	- 7:35 a.m. -	Discovered OIU has locked-up the display screen.
	- 8:00 a.m. -	Pipefitters begin CWF line modifications.
	-	0.065" screens installed.
	- 2:45 p.m. -	Electricians wiring transformer to PCU/OIU.
	-	Quotation received on ceiling fan - $11,000 (30,000 CFM unit)
Apr. 26/88	- 8:00 a.m. -	Awaiting OIU repair by MBPP personnel.
	- 10:30 a.m.-	Meeting with George Bishop re delays in project.
	- 1:30 p.m. -	NSPC visited site.
	- 2:30 p.m. -	Word received project to get top priority. Requested manpower available at noon Apr. 27.
	- 3:30 p.m. -	Propane delivered - 363 liters.
Apr. 27/88	- 8:00 a.m. -	OIU appears to be repaired. Preparing to fire up on HFO.
	- 10:30 a.m.-	Oil Substitution Committee visited site during start-up on oil. OIU locked up again.

	11:30 a.m. -	NRC atomizer developed oil leak at rear gland. Switched atomizers but ignitor went out and could not get ignitor restarted.
	2:00 p.m. -	Diagnosed ignition problem as scanner pressure low - too much instrument air being taken by ignitor.
	3:00 p.m. -	Meeting with MBPP to delegate tasks from items requiring completion. Tradesmen to commence 8 a.m., Apr. 28.
Apr. 28/88	8:00 a.m. -	Pipefitters, welders and instrument personnel on site. Action items being addressed.
Apr. 29/88	8:30 a.m. -	Problems with oil light off. Reset atomizer clearance to improve combustion on HFO.
	10:00 a.m. -	Michelin personnel visited site.
	2:30 p.m. -	Obtained satisfactory combustion on oil.
	3:40 p.m. -	Boiler trip due to deaerator level low - suspected air lock on softener tank pump. Operator manpower shortage prevents operating boiler over weekend.
	-	Commissioning complete.

G.2 Boiler Operation after Commissioning (May '88 - Nov. '88)

The operation of the boiler, after commissioning and start-up, is outlined in the following account. The three dates which are underlined and in bold type identify three major modifications conducted on the system.

Date		Event
May 2/88	- 10:00 a.m.	Boiler light off on oil.
	- 12:00 a.m.	Switched to CWF.
	- 3:15 p.m.	Boiler trip, cause unknown. Ignitor problems trying to restart.
	- 10:15 p.m.	Back on line with CWF.
May 3/88	- 3:00 a.m.	Unstable flame developed. Operator switched guns and went to oil.
	- 8:00 a.m.	Boardmill down. #7 base-loaded on HFO.
	- 2:45 p.m.	First sootblow. 5 min. duration.
	- 3:30 p.m.	Attempt to switch to CWF-failed due to ignitor problems. Disassembled both propane regulators checked out o.k. Enlarged orifice to full bore.
	- 6:40 p.m.	Start up on HFO.
	- 9:15 p.m.	Switch to CWF @ 250 F air temp. Unstable without support ignition.
	- 10:50 p.m.	Ignitor off at 280 F air temp.
May 4/88	- 1:30 a.m.	Switched strainers. Lost flame in process from pressure change.
	- 2:00 a.m.	Switch to HFO.
	- 8:00 a.m.	Samples of strainer deposits taken. Ignitor problems again brought to MBB's attention. Larger one promised by Friday.

		Meanwhile modified air supply to existing ignitor. Sampled air hopper for catch.
	- 7:00 p.m.	Startup on HFO.
	- 8:30 p.m.	Switch to CWF
	- 9:30 p.m.	Fuel leak in pit cleaned up.
May 5/88	- 5:00 a.m.	After 3 boiler trips, switched to oil.
	- 5:30 a.m.	Attempts to switch to CWF failed. Oil temp escalated making restart on oil difficult.
	- 7:30 a.m.	Light off on HFO.
	- 8:30 a.m.	Boiler trip - low drum level. Back up immediately on oil.
	- 9:30 a.m.	Canada Cement LaFarge and NRCC visited. Switch to CWF (changing guns) unsuccessful. Foreign material caught in atomizer. Flushed fuel line.
	- 4:30 p.m.	Technical sub-committee meeting decision to install tertiary holes in front wall of boiler.
	- 5:30 p.m.	Boiler (on oil) taken off line to cool for mods.
May 6/88	- 8:00 a.m.	Began removing 4 window panels to relieve excessive heat near top of fuel tanks.
	- 4:00 p.m.	Manometers installed on burner for pressure measurements and cold test done.
May 7/88	- 8:00 a.m.	7 four inch holes drilled through boiler front wall and 3 inch nipples installed.
	- 11:00 p.m.	Established CWF flame - much improved combustion.

May 9/88	- 8:00 a.m.	Boiler operating smoothly on CWF since Sat. night. Windbox press still high at higher boiler load - flame becomes unstable.
	- 3:30 p.m.	Boiler trip - propane pressure low prevented restarting boiler.
	- 8:00 p.m.	CWF flame established.
May 10/88	- 8.00 a.m.	Boardmill down. Steaming rate down to 12000 lb./hr. (1600 lb./hr. CWF). As air temp dropped, ignitor required to maintain stability.
	- 9:10 a.m.	Switch to HFO. Maintained low load all day.
	- 4:00 p.m.	Boardmill back on line.
	- 6:00 p.m.	Switch to CWF at 253 F air temp.
May 11/88	- 8:00 a.m.	Smooth operation on CWF all night. Adjustments to air flow and dampers made but could not improve on combustion.
	- 6:30 p.m.	Severe oscillations in furnace pressure observed.
	- 9:35 p.m.	Checked air heater hopper and atomizer for cause of oscillations.
	- 9:50 p.m.	Startup on CWF at 241 F air temp.
	- 10:20 p.m.	Oscillations have ceased (cause undetermined).

May 12/88	- 8:20 a.m.	Shut down boiler to switch to 80° tip on oil. Removed ash catch from air heater hopper (10½ hr. CWF firing only). Removed ½ bbl. of ash.
	- 9:45 a.m.	Startup on HFO.
	- 11:00 a.m.	Switch to CWF on 70° tip.
	- 1:00 p.m.	Improper adjustment of atomizer resulted in major deposit on furnace floor and heavy emissions at stack. Switched back to oil to burn out deposit.
	- 2:15 p.m.	Soot blew for 5 mins.
	- 3:00 p.m.	Return to CWF with 60° tip.
May 13/88	- 4:00 a.m.	Strainer #1 isolation valve stem stripped. Boiler switched to HFO while cleaning strainer.
	- 6:00 a.m.	Switched back to CWF.
	- 7:30 a.m.	PSID gauge at strainers observed to be sticking.
	- 9:00 a.m.	Skewed flame and increase in fuel pressure. Shutdown to clean atomizer - wood fibre found lodged in atomizer. Crack observed in ceramics (alumina). Gun and fuel lines flushed.
	- 1:15 p.m.	Switched to CWF.
	- 1:30 p.m.	Site visit by Dept. of Mines & Energy.

May 16/88	- 12:00 a.m.	Boiler ran smoothly all weekend on CWF. Shutdown to cool for windbox mods on Tues.
May 17/88	- 1:30 p.m.	All 3" nipples in windbox have been removed. An 8th four-inch hole placed in inner manway. All tertiary air ports are now 4" diameter. Cleaned out air heater hopper.
	- 7:30 p.m.	Completed air flow pressure measurements on windbox. NRC contacted to supply 70° tip.
May 18/88	- 7:30 a.m.	Delay in starting boiler while decision made by MBPP whether or not to support overtime for operators required to man both boiler houses.
	- 12:00 a.m.	Boiler started on HFO (60° Nitride tip). Adjustments to burner during afternoon to optimize on oil. #2 oil pump only capable of 2500 lb./hr.
	- 4:55 p.m.	Soot blew.
	- 5:10 p.m.	CWF tank level gauge not working.
	- 5:40 p.m.	Switch to CWF. Unsupported combustion but high degree of instability at 3700 lb./hr. CWF.
	- 7:30 p.m.	Reduced firing rate to 3000 lb./hr. Stability improved.
May 19/88	- 8:00 a.m.	Boiler operated all night on CWF with no problems. (2500 lb./hr. CWF avg.)

	- 12:30 p.m.	Small 1/8" hole plate installed in #1 strainer housing replacing 4 foot screen baskets.
	- 5:00 p.m.	Adjustments to burner settings improved combustion significantly. Achieved 41,000 lb./hr. steam (4270 lb./hr. CWF) on 60° tip.
	- 6:00 p.m.	Switched to 70° tip (Zirconium-Alumina).
	- 7:30 p.m.	Attained 43,570 lb./hr. steam at 4761 lb./hr. CWF (50 MMBtu/hr. input).
May 20/88	- 3:00 a.m.	Load down as low to 1800 lb./hr. CWF and 17000 lb./hr. steam for approx. 15 minutes. Air temp. dropped to 250 F but no signs of instability.
	- 8:30 a.m.	Firing rate reduced to 1741 lb./hr. CWF (18 MMBtu/hr.).
	- 10:00 a.m.	Air temp stabilized at 255 F, steam flow 16,280 lb./hr. and fuel flow 1739 lb./hr. CWF. Stable tightly swirled flame. Burner turndown of 2.7:1 clearly demonstrated.
May 21/88	- 10:20 p.m.	Boiler shutdown for weekend and cool down for mods to windbox on Monday.
May 24/88		Pipefitters prepared 8 four-inch nipples for installation in windbox. Steam coil in air heater on all weekend. Windbox too hot to enter. OIU problems identified. Main steam line size increased at bottleneck over weekend.

May 25/88	- 7:30 a.m.	Small fuel strainer inspected.
	- 8:00 a.m.	OIU board replaced. Power-outage over weekend possible cause.
	- 2:00 p.m.	4" nipples installed. Inspection of windbox revealed uneven secondary vane spacing - likely due to parallax error. Reset. 5 MMBtu propane ignitor arrived. Adaptor parts being fabricated in machine shop. 4' x 4' hole in ceiling opened for vent fan installation.
	- 7:00 p.m.	Light off on oil.
	- 7:27 p.m.	Raising steam.
	- 10:00 p.m.	Boiler #5 shut off and #7 carried plant at 150 - 155 psi with 5 psi drop from #7 to #5 boiler house (oil firing).
	- 10:45 p.m.	Switched to CWF without switching atomizers.
May 26/88	- 8:30 a.m.	Two trips reported overnight due to power outages/surges but back up immediately on CWF each time.
	- 1:50 p.m.	Boiler outage due to planned power interruption at plant.
	- 5:15 p.m.	Power back on. Boiler started on CWF at air temp207F. Ignitor off after 10 mins. Air temp 211 F.
	- 7:00 p.m.	Problem developing with deaerator steam control valve causing huge fluctuations in feedwater temperature and boiler steaming rate.

May 27/88	- 10:15 a.m.	Removed small strainer basket after 36 hours continuous operation for cleaning and inspection.
	- 7:00 p.m.	Boiler shutdown for weekend. During afternoon, achieved 51,190 lb./hr. steam at 6329 lb./hr. CWF (66.5 MMBtu) for approximately ½ hour. Boiler #5 off line and 8 - 10 psi drop observed between boilerhouses. Heavy paper (grade 337) being run in mill.
May 30/88		Boiler opened for thorough first inspection after operation on CWF. Details reported at Technical Steering Committee meeting on Tuesday.
	- 4:00 p.m.	Technical Sub-Committee meeting - refer to minutes.
May 31/88		Further inspection, measurements and photographs of boiler internals. Completed installation of new ignitor.
	- 1:30 p.m.	Technical Steering Committee meeting at Minas.
June 1/88	- 11:00 a.m.	Tried new ignitor for first time. Works perfectly and a vast improvement over the old one.
	- 12:30 p.m.	Fired up on oil.
	- 2:30 p.m.	Switched to CWF (70° tip) without changing guns.
June 2/88	- 7:30 a.m.	Wore out first atomizer tip (70°). Replaced with 60° (only one available).

June 3/88	1:00 a.m.	Boiler went out due to low scanner pressure. Belts broke on air compressor. Repaired and boiler put back on-line.
	7:00 a.m.	Strainer cleaned and boiler put back on-line.
June 4	4:30 p.m.	Changed guns (grey nitrite tip).
June 5		Steady operation using CWF.
June 6	3:00 p.m.	Strainer cleaned.
	8:35 p.m.	Opened steam to deaerator.
June 7	5:00 a.m.	Changed guns.
	11:00 a.m.	Boiler tripped (no apparent reason), put back on-line using CWF.
June 8	1:00 a.m.	Cleaned strainer.
	3:30 p.m.	Sootblow for 5 mins.
	10:00 p.m.	Cleaned strainer.
June 9	9:00 p.m.	Cleaned strainer.
June 10	8:00 p.m.	Steam flow fluctuating from 20,000 lb./hr. to 37,000 lb./hr. due to erratic feedwater flow.
June 11	4:40 a.m.	Cleaned strainer.
June 12		Smooth operation on CWF.
June 13	6:00 p.m.	Closed gap on burner to raise fuel pressure.
June 14	3:00 a.m.	Changed strainers.
	8:45 a.m.	Changed burners.
June 15		Smooth operation using CWF.
June 16	3:15 a.m.	Cleaned strainer.

June 17	6:00 p.m.	Switched to HFO in order to install new strainers. Changed to gun #1 (70° tip.
	8:10 p.m.	Switched to CWF.
June 19	10:00 p.m.	Changed and cleaned strainers.
	10:15 p.m.	Changed and cleaned strainers.
June 21	11:00 a.m.	Flame slightly unstable. Blew gun #1.
June 22	10:30 a.m.	Changed and cleaned strainers.
	2:00 p.m.	Swiched to Gun #2, Gun #1 partially plugged. Cleaned Gun #1 and Strainers.
June 23	8:00 a.m.	Boardmill down.
June 24	12:45 a.m.	Boiler tripped due to low water level. Boiler pressure dropped to 60 psig in 10 mins.
	10:00 a.m.	Cleaned strainer.
	4:30 p.m.	Blew lines.
June 25	12:05 p.m.	Tripped boiler in order to reset OVR. Could not re-light boiler on CWF. Switched to HFO
	2:30 p.m.	Switched to CWF.
	4:30 p.m.	Cleaned strainer.
June 26	9:00 a.m.	Boiler tripped due to power surge.
	12:05 p.m.	Fuel strainer switched and cleaned.
	3:55 p.m.	Shutdown due to power outage. Blew gun out.
June 27	1:10 a.m.	Power outage, boiler tripped. Couldn't re-light on CWF. Switched to HFO.

	8:00 a.m.	Switch to CWF.
	9:19 a.m.	Strainer and gun both plugged. Switch to HFO. Changed burner tip.
	7:45 p.m.	Switch to CWF.
June 28	9:00 a.m.	Soot blew tubes, cleaned strainer.
June 29	2:20 a.m.	Replaced rupture disk.
	5:20 a.m.	Opened clearance on burner tip to reduce fuel pressure.
	2:30 p.m.	Cleaned strainer.
	7:30 p.m.	Switched burner due to unstable flame.
June 30	11:45 a.m.	Cleaned strainer.
	12:05 p.m.	Feedwater flow control is on cascade.

July 1-6		Shutdown for boiler modifications - replace 13½" primary air can with a 14½" can, and install screen around burner.
July 4	8:30 a.m.	Inspected furnace interior. (See Appendix J, Photographs for details).
	10:30 a.m.	MBB personnel installed 14½" air can swirler.
July 5		MBB personnel installed sample port and temperature sensor port on feedwater line from deaerator to feedwater pump.
		Cleaned ash out of boiler (removed 3 - 4 barrels of ash).
July 6		Attempt to fire boiler on oil, failed due to misalignment of burner.
	3:15 p.m.	Swirl plate rewelded and primary air can back on.
	5:00 p.m.	Start-up using HFO.
July 7	8:00 a.m.	Operating smoothly on CWF.
	9:30 a.m.	Preparing to switch to Gun #2 with 70° ceramic tip. Boiler #6 went out and would not restart. Start-up #5 boiler in interim.
	11:30 a.m.	Start-up on CWF with Gun #2 (70° tip).
	1:40 p.m.	Achieved 5000 lb./hr. CWF and 41,900 lb./hr. steam flow.
	2:20 p.m.	Insurance Inspector to check low water level trip. Changed to Gun #1 (60° tip).
	3:00 p.m.	Back on-line after trip test. Poor flame with Gun #1 (60° tip). Boiler tripped on low drum level.

	3:30 p.m.	Back on-line wih Gun #2 and 60° alumina tip.
July 8	9:00 a.m.	Feedwater flow put on cascade.
	6:40 p.m.	Cleaned strainer. New sump pump burnt out, replaced with old pump.
July 9	8:30 a.m.	Boiler down for weekend.
July 10		Joel MacLean on site Saturday and Sunday to train instrumentation personnel.
July 11	5:30 a.m.	Attempt start-up with CWF, failed. Too cool to start, air temp at 260°F and dropped to 230°F during attempt.
	6:00 a.m.	Switched to HFO.
	8:00 a.m.	Attempt to switch to CWF, failed.
	8:30 a.m.	Switch to HFO, Gun #2 adjusting rod broke at universal joint. Repaired.
	9:00 a.m.	EMR personnel arrived on site.
	12:45 p.m.	Switched to CWF at 259°F temp. using Gun #1 (60° alumina tip).
	5:00 p.m.	Switched to Gun #2 (70° tip) at 270°F temp. Better flame than with Gun #1 (60° tip).
	7:00 p.m.	Power surge, mill shutdown temporarily and so did boiler #7. Must reach steady state (SS) at combustion air temp of 293°F and 3300 lb./hr. CWF for a 35 MMBtu gas test.
	8:30 p.m.	Began taking readings at 35 MMBtu level.
	10:00 p.m.	Completed readings and SS run.

July 12	8:00 a.m.	Unstable flame - a lot of sparks present. Build-up in throat necessitated shutdown and switch to HFO to burn out deposits in throat and on floor.
	8:50 a.m.	Using HFO, 60° tip, 50° vane, EMR carried out HFO test (Gun #1).
	1:50 p.m.	Switched to CWF, 70° tip, 50° vane (gun #3). Accumulation of dried fuel in the lower forward part of the atomizer. Flushed out easily, this may have been causing the sparks.
	3:00 p.m.	Operated boiler at 2300 lb./hr. CWF (low-end) and conducted EMR low-end test.
July 13	10:00 a.m.	Began 3300 lb./hr. CWF test at low oxygen conc. (@3%).
	12:00 noon	Test completed, will attempt high-end test at 6:00 p.m.
	6:00 p.m.	Blew a rupture disk at 120 psi burner pressure and 4000 lb./hr. CWF. Unsure of cause. Switched to new disk, cleaned out Gun #2, changed filters, and re-inserted Gun #2.
	7:00 p.m.	Blew second rupture disk at 120 psi and 4000 lb./hr. CWF. Switched to HFO. The HFO was cold and very difficult to start.

	10:10 p.m.	Boiler outage. Possibly gun may have been blocked. Fuel flow at 4500 lb./hr. CWF and 42,000 lb./hr. steam. Fuel pressure at 118 psi and rising. Operator attempted to clear gun via gap adjustment.
July 14	3:00 a.m.	Could not establish consistent CWF flame. Switched to HFO.
	8:00 a.m.	Operated on HFO, flushed CWF line this morning for an hour before starting on CWF. Requested jumper open on CWF valve in pit. When jumpered, boiler tripped. Instrumentation personnel in to reconfigure OIU.
	9:15 a.m.	Switched to CWF and established a suitable CWF flame. Personnel from PREPA arrived for a site tour.
	12:22 p.m.	Poor atomization observed possibly due to plugging of atomizer. Switched to HFO. Buildup in throat occurred. Suspect wear on ceramic cone is affecting atomization quality. Contacted Adam Bennett (NRCC) to courier a replacement tip immediately. Boiler will remain on HFO until the new tip arrives.
July 15		Boiler #7 down for weekend, boiler #6 on.

July 18	1:12 a.m.	Cracked by-pass valve to #7 boiler.
	4:00 a.m.	Attempt to start up on CWF, failed. Switch to HFO. New ceramic tips received.
July 19	6:42 p.m.	Switched to CWF, successful.
	7:00 p.m.	Wind change across town, switched to HFO because of particulate fallout when operating on CWF.
	9:15 p.m.	Attempt switch to CWF, failed. Switched to HFO.
July 20	7:50 a.m.	Soot blew.
	11:20 a.m.	Switch to CWF. Poor flame stability, purged and re-started on CWF several times but could not achieve stable combustion. Switched to HFO. Cleaned Gun #1, remained on HFO rest of day.
July 21		CWF line purged. Boiler #7 emitting heavy smoke when operating on HFO. Excess O_2 must be set fairly high (@7-10%).
	10:30 a.m.	Soot blow.
	3:05 p.m.	Switched to CWF, unsuccessful. Switched to HFO.
	6:50 p.m.	Switched to CWF but could not achieve stable combustion. Switched to HFO.
July 22		Boiler #7 down for weekend.

July 25	8:00 a.m.	Operating on HFO all day.
	3:00 p.m.	Shutdown to change prim. can back to 13½. CBDC and NRC on site.
July 26	3:30 p.m.	Switched to CWF, changed guns.
	6:20 p.m.	Changed and cleaned strainers.
July 27	12:40 a.m.	Burner appeared to be plugged. Opened burner gap.
	1:20 a.m.	Changed guns. Lost ignitor, had to purge boiler. Second gun plugged 15 min. later. Switched to HFO, cleaned guns.
	3:40 a.m.	Switched to CWF. Installed finer mesh screen. Removed gauge glass from boiler #7, cleaned packing rings and re-installed gauge.
July 28	12:05 a.m.	Wind across town, switched to HFO.
	3:30 p.m.	Switched to CWF. Flame pulsating, reduced burner gap.
	5:55 p.m.	Gun #1 plugged, switched to Gun #2. Changed strainers.
	11:55 p.m.	Operating on CWF, poor flame stability.
July 29	1:00 a.m.	Changed strainers, reduced gap on burner and quickly opened, obtained improved flame stability. Quickly closing and opening gap appeared to clean out nozzle.

	2:30 p.m.	Changed guns. Could not re-light, too much atomizing steam. Changed strainers and re-started.
	3:30 p.m.	Blew a rupture disk, switched to HFO. Wind direction across town, remained on HFO rest of day.
August 1	10:45 p.m.	Wind direction changed towards shore, switched to CWF (very smooth switch).
August 2	3:00 a.m.	Wind across town, switched to HFO.
	4:30 a.m.	Cleaned strainer.
	1:00 p.m.	Switched to CWF. Gun #1 plugging, changed to Gun #2.
	5:50 p.m.	Changed and cleaned strainers.
	7:55 p.m.	Changed to Gun #1.
	10:50 p.m.	Changed and cleaned strainers.
August 3	12:30 a.m.	Wind across town, switched to HFO. Changed burners and cleaned both strainers.
	8:45 a.m.	Switched to CWF.
	10:00 a.m.	Changed and cleaned strainer.
	2:40 p.m.	Soot blew for 5 mins.
	3:00 p.m.	Changed and cleaned strainer.
	7:00 p.m.	Changed and cleaned strainers
	11:00 p.m.	Changed and cleaned strainers.

August 4	1:15 a.m.	Began losing flame, changed guns, cleaned strainer, and backwashed filters. Re-established stable flame.
	9:30 a.m.	Changed guns.
	2:40 p.m.	Boiler went out. Changed guns, cleaned strainer and restarted on CWF.
	7:00 p.m.	Changed and cleaned strainer.
	11:00 p.m.	Power surge, #6 boiler tripped, #7 boiler went out. Changed guns on #7 boiler and re-started on CWF.
August 5	5:20 a.m.	Changed and cleaned strainer.
	2:50 p.m.	Blew rupture disk. Changed and cleaned strainer while boiler was down.
	10:45 p.m.	Changed and cleaned strainer.
	11:30 p.m.	Wind change across town. Switched to HFO.
August 6	5:45 a.m.	Due to low steam load, shutdown boiler #7 and cleaned boiler #6.
	7:00 a.m.	Warmed up boiler #5, boiler #7 down for weekend.
August 8	10:30 p.m.	Wind towards shore, switched to CWF.
	11:00 p.m.	Changed guns and cleaned strainer.
August 9	3:00 a.m.	Changed and cleaned strainer.
	3:30 a.m.	Drum level changes causing load swings, switched fuel to manual control to try and even drum level.
	5:00 a.m.	Changed and cleaned strainer.

	11:00 a.m.	Soot blew for 1 minute.
	7:00 p.m.	Changed and cleaned strainer.
	10:30 p.m.	Changed and cleaned strainer.
	10:36 p.m.	Boiler went out. Purged boiler and re-started on CWF. Fuel pressure dropped 26 psi after purge.
August 10		Smooth operation on CWF, routine maintenance.
	11:00 p.m.	Load on #6 and #7 boiler low.
August 11	3:30 a.m.	Changed and cleaned strainers, and backwashed filters.
	6:00 a.m.	Boardmill down to replace bearing.
		Smooth operation on CWF, routine maintenance.
August 12		Smooth operation on CWF, routine maintenance.
	3:30 p.m.	#2 CWF tank getting low. Switched to #1 tank.
August 13		Smooth operation on CWF, routine maintenance.
	8:00 a.m.	Boiler down for weekend.
August 15	7:10 a.m.	Wind across town, switched to HFO.
		Technical Sub-Committee meeting (see minutes).
August 16	5:45 a.m.	Switched to CWF. Smooth operation, routine maintenance.
	9:13 a.m.	Switched CWF tanks.
	8:00 p.m.	Gun appeared to be plugging, changed guns.
August 17		Smooth operation on CWF, routine maintenance.
	3:35 a.m.	Gun plugged, changed to Gun #1. Gun #2 worn excessively. Replaced tip.

	11:30 a.m.	Changed guns.
	4:00 p.m.	Changed to Gun #1 and cleaned strainer.
	6:30 p.m.	Changed to Gun #2, could not adjust gap on Gun #1.
August 18		Smooth operation on CWF, routine maintenance.
	9:14 a.m.	Shutdown to purge gun, clean ball checks on sulphite pump, and cleaned strainer.
	9:40 a.m.	Soot blew for 3½ minutes.
	10:08 a.m.	Back on-line with CWF.
	7:00 p.m.	Gun #2 plugging, switched guns.
August 19		Smooth operation, routine maintenance.
	5:52 a.m.	Changed guns.
	8:00 a.m.	Boiler #7 down, cleaned Gun #2 and repaired Gun #1.
	9:30 a.m.	Back on-line, smooth operation on CWF, routine maintenance.
August 20		Smooth operation on CWF, routine maintenance.
	8:00 a.m.	Boiler down for weekend.
August 22	7:02 a.m.	Start-up on HFO.
	2:40 p.m.	Switched to CWF, smooth operation, routine maintenance.
	10:40 p.m.	Changed guns.
August 23		Smooth operation on CWF, routine maintenance.
	1:00 p.m.	Changed guns.
	4:00 p.m.	Soot blew for 1 minute.
	6:30 p.m.	Blew rupture disk, changed-guns and cleaned strainer.
August 24		Smooth operation on CWF, routine maintenance.
	3:45 p.m.	Changed guns.

August 25		Smooth operation on CWF, routine maintenance.
	11:00 a.m.	Wind change across town, switched to HFO.
August 26		Wind across town all day. Remained on HFO. Boiler down for weekend.
August 29	7:50 a.m.	Start-up on HFO.
	1:38 p.m.	Switched to CWF, smooth operation, routine maintenance.
August 30		Grand Opening Day at MBPP.
		Smooth operation on CWF, routine maintenance.
	1:00 p.m.	Changed guns.
August 31		Smooth operation on CWF, routine maintenance.
	11:45 a.m.	Wind across town, switched to HFO.
	5:25 p.m.	Switched to CWF, smooth operation, routine maintenance.
Sept. 1		Smooth operation on CWF, routine maintenance.
	9:00 a.m.	Soot blow for 1 minute.
Sept. 2		Smooth operation on CWF, routine maintenance.
	8:30 p.m.	Soot blew for 1 minute.
Sept. 3		Smooth operation on CWF, routine maintenance.
	7:30 a.m.	Boiler down for weekend.
Sept. 6	8:03 a.m.	Start-up on HFO.
	10:30 a.m.	Switched to CWF. Changed guns.
	4:30 p.m.	Changed guns.
	8:00 p.m.	Changed guns (broken tip on Gun #1).

Sept. 7		Smooth operation on CWF, routine maintenance.
	8:00 p.m.	Changed guns.
Sept. 8		Smooth operation on CWF, routine maintenance.
	7:05 a.m.	Strainers backwashed.
	2:00 p.m.	Changed guns.
Sept. 9		Smooth operation on CWF, routine maintenance.
	3:10 p.m.	Wind change across town, switched to HFO.
Sept. 10	4:30 p.m.	Wind change towards shore,- switched to CWF.
	5:00 p.m.	Switched to Gun #1, problems starting up.
	8:00 p.m.	Switched to HFO.
	9:35 p.m.	Switched to CWF, successful.
Sept. 11		Smooth operation on CWF, routine maintenance.
	6:13 a.m.	Shutdown boiler to purge. Main flame scanner circuit board is loose.
Sept. 12		Smooth operation on CWF, routine maintenance.
	10:35 a.m.	Changed to Gun #1.
	12:45 p.m.	Sootblow for 2 minutes.
	2:15 p.m.	Changed gun to Gun #2.
Sept. 13	1:00 a.m.	Changed guns to Gun #1. Smooth operation on CWF, routine maintenance.
Sept. 14		Smooth operation on CWF, routine maintenance.
	8:15 a.m.	Boardmill down, #7 boiler shutdown.
	4:45 p.m.	Start-up on HFO.
	7:30 p.m.	Switched to CWF, very unstable operation.
	10:30 p.m.	Changed and cleaned strainer.

Sept. 15	4:00 a.m.	Blew rupture disk and burnt-out coil in automatic valve by strainers.
	4:30 a.m.	Re-started on HFO.
	11:43 a.m.	Switched to CWF, changed to Gun #2.
Sept. 16		Smooth operation on CWF, routine maintenance.
	11:12 p.m.	Water filters backwashed for 1 hour.
Sept. 17		Smooth operation on CWF, routine maintenance.
	4:42 p.m.	Changed to Gun #1.
Sept. 18		Smooth operation on CWF, routine maintenance.
Sept. 19		Smooth operation on CWF, routine maintenance.
Sept. 20		Smooth operation on CWF, routine maintenance. (Still using Gun #1.)
Sept. 21		Smooth operation on CWF, routine maintenance.
	8:35 a.m.	Boardmill shutdown for the day, #7 boiler shutdown.
	2:37 p.m.	Start-up on HFO.
	4:50 p.m.	Switched to CWF, failed. Switch to HFO.
	5:46 p.m.	Heavy smoke from boiler with HFO.
Sept. 22	1:10 a.m.	Switch to CWF, smooth operation, routine maintenance. Operating with Gun #2. NSRF on site to set up for flyash testing.
Sept. 23		Smooth opeation on CWF, routine maintenance.
	11:00 a.m.	Canmet equipment arrived for NSRF test.

	2:15 p.m.	Changed to Gun #1. Boiler modification drawings reviewed by CBDC at MBB, Halifax
Sept. 24		Smooth operation on CWF, routine maintenance.
	3:14 p.m.	Sootblow for 2 minutes.
Week 27		
Sept. 25		Smooth operation on CWF, routine maintenance.
	7:10 p.m.	Changed to Gun #1.
Sept. 26		NSRF on site to begin tests. Smooth operation on CWF, routine maintenance.
	9:37 a.m.	Wind across town, switched to HFO.
	10:50 a.m.	Boiler down to clean hopper.
	3:45 p.m.	Restarted on CWF, smooth operation, routine maintenance. Changed to Gun #2.
Sept. 27		Smooth opeation on CWF, routine maintenance.
	10:00 a.m.	Boiler placed on manual control in order to conduct stack tests.
Sept. 28		Smooth operation on CWF, routine maintenance.
	4:50 a.m.	Changed to Gun #1.
	10:30 a.m.	Low steam load, boiler #7 shutdown.
	4:05 p.m.	Restart on HFO.
	5:08 p.m.	Switched to CWF, smooth operation, routine maintenance.
Sept. 29		Smooth operation on CWF, routine maintenance.
	5:35 p.m.	Changed to Gun #2.
Sept. 30		Smooth operation on CWF, routine maintenance. NSRF testing completed.

Oct. 1		Smooth operation on CWF, routine maintenance.
	8:00 a.m.	Wind across town, switched to HFO.
	2:15 p.m.	Wind towards shore, switched to CWF, smooth operation, routine maintenance.
Oct. 2		Smooth operation on CWF, routine maintenance.
	9:30 a.m.	Wind across town, switched to HFO.
Oct. 3	1:45 p.m.	Wind towards shore, switched to CWF, Gun #1. Smooth operation, routine maintenance.
	5:10 p.m.	Changed and cleaned strainers.
	11:02 p.m.	Changed and cleaned strainers.
Oct. 4		Smooth operation on CWF, routine maintenance.
	4:45 a.m.	Flame looks good at high load - 4800 lb./hr. CWF and 39,600 lb./hr. steam.
Oct. 5		Smooth operation on CWF, routine maintenance (still using Gun #1).
	11:00 p.m.	Strainer very dirty when changed.
Oct. 6		Smooth operation on CWF, routine maintenance.
	8:05 a.m.	Boiler shutdown for cleanup.
	2:08 p.m.	Restart on HFO.
	6:43 p.m.	Switched to CWF, smooth operation, still using Gun #1.
Oct. 7		Smooth operation on CWF, routine maintenance.
	10:40 a.m.	Purged Gun #1. cleanup.

Oct. 8		Smooth operation on CWF, routine maintenance. (Still using Gun #1.)
	1:00 p.m.	Boiler shutdown.
Oct. 11		Furnace inspection by CBDC and begin modifications by MBB decided upon during August 15-16 Tech Sub-Committee meeting.
Oct. 12		Furnace cleaned of ash. Mods continue.
Oct. 13		Furnace mods continue.
Oct. 14		Furnace mods continue.
Oct. 15		Ultrasonic tests of boiler rear wall tubes and first row screen tubes by MBB (see Appendix L).
Oct. 18	5:00 p.m.	Start-up on HFO.
	11:40 p.m.	Shutdown new tertiary damper and vanes seized. Boiler allowed to cool to permit welding repairs to damper and vanes.
Oct. 19	12:37 p.m.	Start-up on HFO.
	1:00 p.m.	Sootblow for 1½ minutes.
Oct. 20	1:24 p.m.	Switched to CWF, smooth change.
	10:45 p.m.	Changed to Gun #2.
Oct. 21		Smooth operation on CWF, routine maintenance.
	8:30 a.m.	Changed to Gun #1.
Oct. 22		Boiler does not operate well at low loads since last modifications were completed. Smooth operation at high load.
	8:00 a.m.	Wind across town, switch to HFO.

Oct. 23	9:00 a.m.	Wind towards shore. Switched to CWF, smooth operation, routine maintenance.
Oct. 24	12:28 a.m.	Flame unstable, changed to Gun #2 but could not relight. Switched to HFO.
	6:30 a.m.	Switched to CWF, smooth operation.
	8:10 a.m.	Changed to Gun #1.
	1:10 p.m.	Wind across town, switched to HFO.
	5:03 p.m.	Drum level dropped during low load operation on HFO.
Oct. 25	2:00 p.m.	Wind towards shore, switched to CWF. Smooth operation, routine maintenance. Gun #1.
	10:30 p.m.	Sootblow for 2½ minutes.
Oct. 26		Fuel flow fluctuating at high load.
	8:10 a.m.	Boiler down due to low load.
	5:20 p.m.	Wind across town, start-up on HFO.
	7:30 p.m.	Switched to CWF. Fuel flow still fluctuating at high load. Changed fuel flow control to manual.
Oct. 27	1:34 a.m.	Changed to Gun #2.
	9:00 a.m.	Wind across town, switched to HFO.
	6:15 p.m.	Wind toward shore, switched to CWF. Smooth operation, routine maintenance.
	10:10 p.m.	Changed to Gun #1.
Oct. 28	1:05 a.m.	Changed to Gun #2 because of unstable flame. Tertiary Damper is stuck in closed position.
	7:30 a.m.	Wind across town, switched to HFO. Remained on HFO due to wind conditions. Repaired tertiary damper.

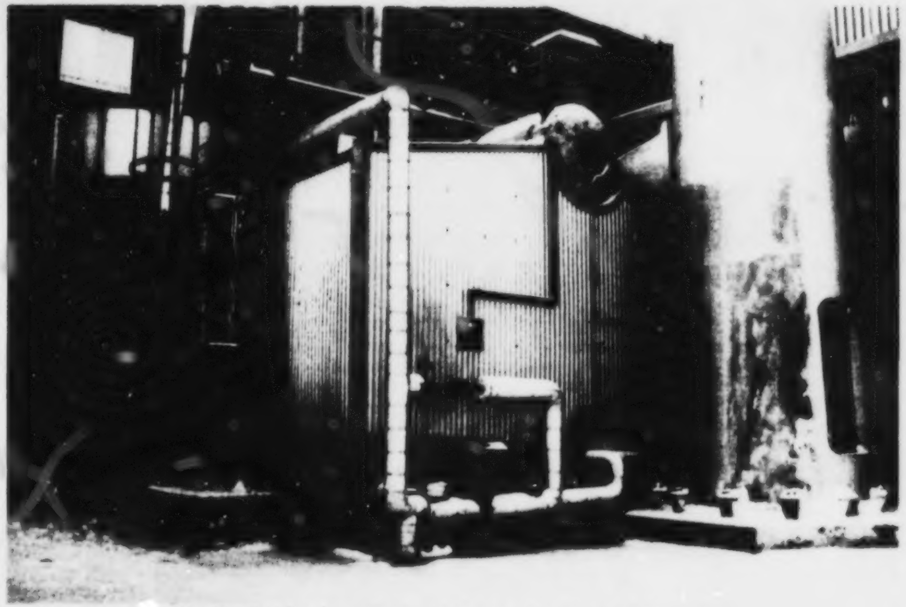
Oct. 29	10:38 p.m.	Wind towards shore, switched to CWF. Switch to cascade.
Oct. 30		Smooth operation on CWF, routine maintenance. Fluctuations in fuel flow ceased once the strainer had been thoroughly cleaned.
Oct. 31	5:30 a.m.	Boardmill down, boiler shutdown.
	6:45 a.m.	Start-up on HFO.
	1:04 p.m.	Swtiched to CWF, smooth operation, routine maintenance.
Nov. 1	2:01 a.m.	Blew rupture disk.
	2:15 a.m.	Unstable flame, changed to Gun #2 but didn't stabilize flame. Switched to HFO.
	3:15 a.m.	Cleaned automatic strainer - plugged solid around outer basker.
	7:00 a.m.	Switched to CWF, flame slightly unstable.
	2:00 p.m.	Wind across town, switched to HFO.
Nov. 2		Power surge knocked out forced-draught fan causing boiler outage.
	11:30 a.m.	Entire mill shutdown.
	4:03 p.m.	Start-up on HFO.
Nov. 3		Remained on HFO due to wind conditions.
Nov. 4	6:20 a.m.	Wind off shore, switched to CWF.
	9:45 a.m.	Boiler down due to instrumentation failure.
	11:45 a.m.	Start-up on HFO and remain on HFO due to wind conditions.
Nov. 5		Remain on HFO due to wind conditions.

Nov. 6		Remain on HFO due to wind conditions.
Nov. 7		Remain on HFO due to wind conditions.
	10:00 a.m.	Shutdown to inspect air heater hopper and make minor modifications.
	5:30 p.m.	Ortech in to conduct stack gas tests on HFO.
Nov. 8		Remain on HFO due to wind conditions. Ortech stack gas test on #6 boiler.
Nov. 9		Remain on HFO due to wind conditions.
	5:25 p.m.	Switched to CWF and changed to Gun #2. Ortech ran CWF particulate emissions rate test during night.
Nov. 10	5:10 p.m.	Wind across town, switched to HFO.
Nov. 11		Reamin on HFO due to wind conditions.
Nov. 12		Remain on HFO due to wind conditions.
Nov. 13		Remain on HFO due to wind conditions.
Nov. 14	2:57 p.m.	Switched to CWF.
	7:37 p.m.	Poor flame on low load. Difficult to keep boiler lighted on CWF.
	8:45 p.m.	Increased burner gap to lower fuel pressure.
Nov. 15	6:15 a.m.	Boiler would not stay lighted on CWF, switched to HFO. Had boiler steam load up to 55,000 lb./hr.

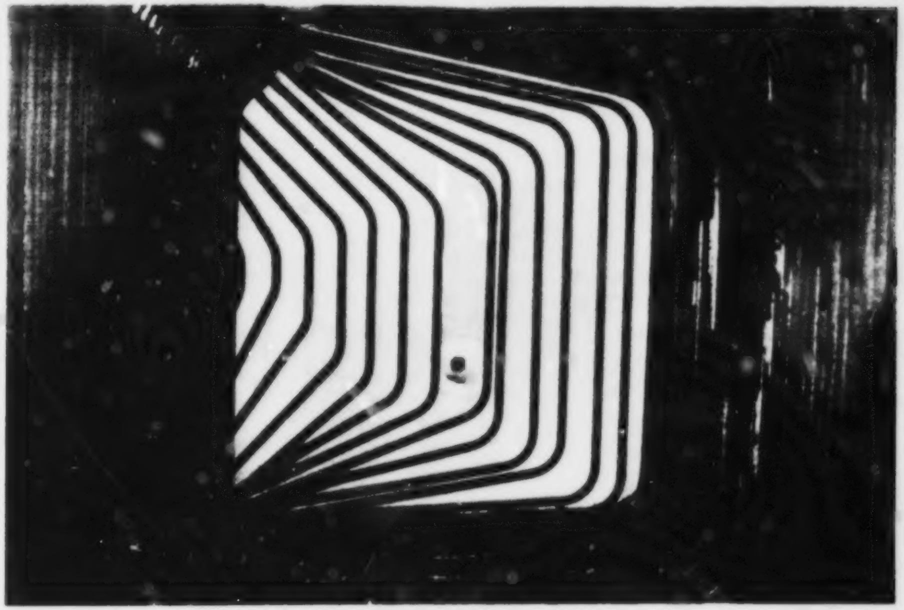
	for 15 mins. but water level dropped steadily. Flow reduced to bring water level up.
Nov. 16	Boiler remained on oil due to wind direction.
Nov. 17	Boiler remained on oil. Attempts to fire CWF all resulted in unstable fire.
Nov. 18	CBDC on site. Inspection of ceramics revealed excessive wear and likely cause for unstable firing conditions. Decision by MBPP & CBDC to shut down #7 boiler until flame scanning improvements could be made.
Nov. 24	CBDC and Bailey Controls Ltd. on site to diagnose flame scanner modifications required. Boiler fired on HFO and CWF for observation purposes. Excellent flame established on CWF using new ceramics.
Nov. 25	CBDC decision to curtail further production of CWF until oil price strengthens and Minas can take delivery of more CWF.
Jan 10/89	Curtailment reversed.

APPENDIX H

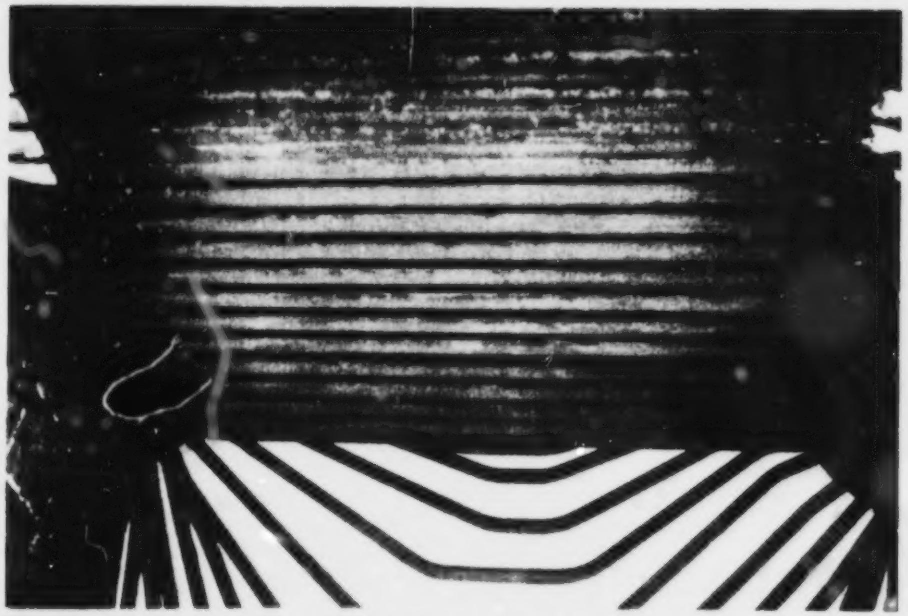
PHOTOGRAPHS



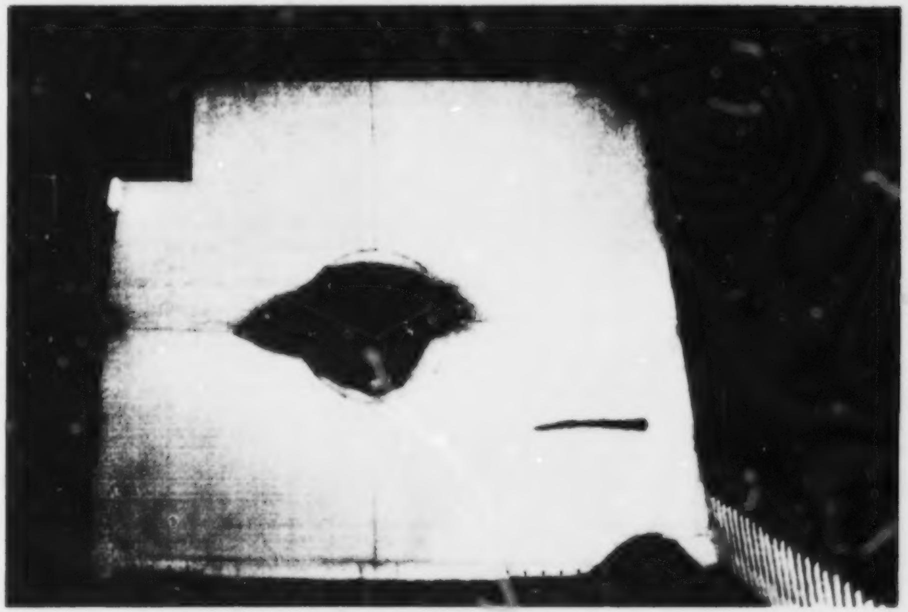
H-1:Original boiler installation,
AECL, Glace Bay, N.S.



H-2:Boiler backwall (original)

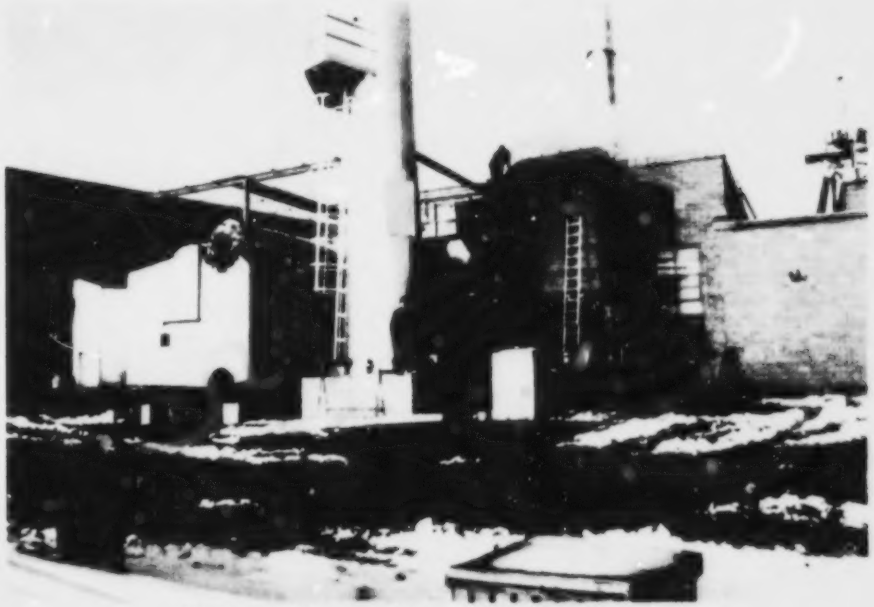


H-3:Gaspass entry (original)



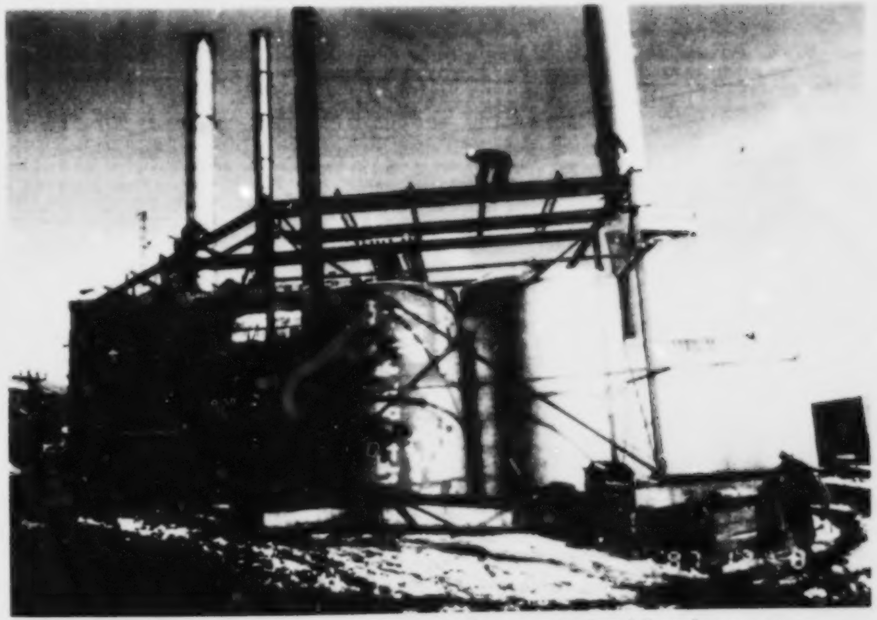
H-4:Boiler frontwall (original)

H-5:Boiler site at MBP&P
(before construction)

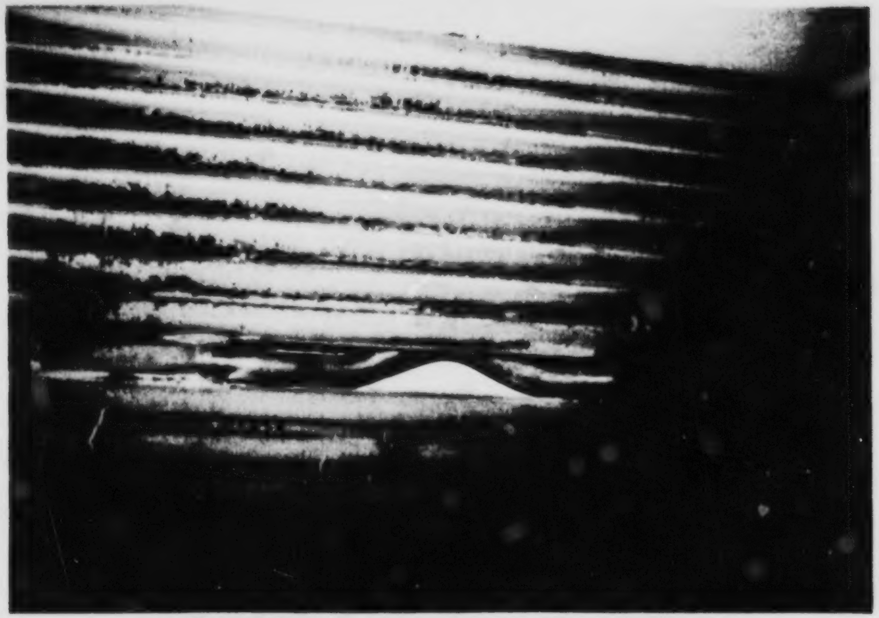


H-6:Boiler site at MBP&P
(during construction)

H-7:Construction of foundation

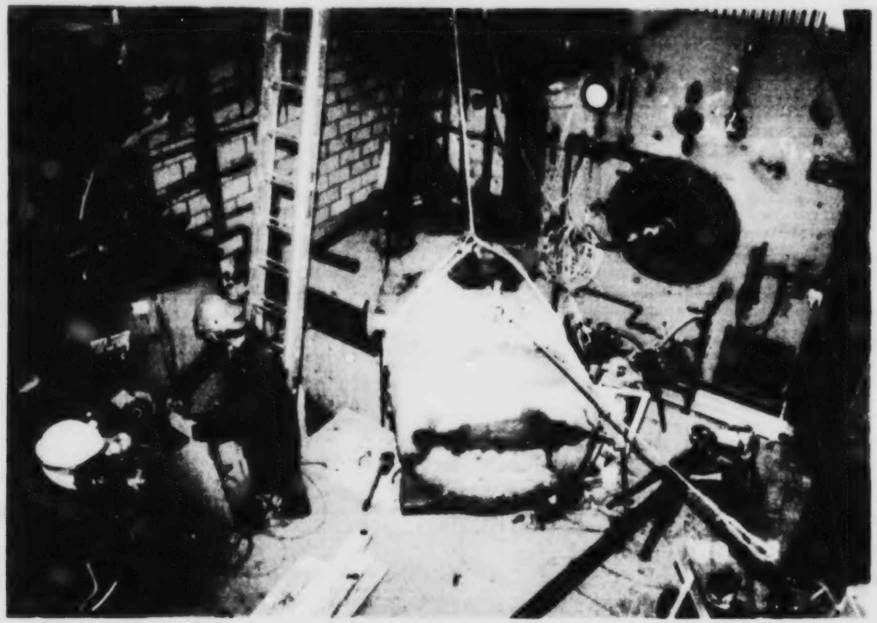


H-8:Construction of boilerhouse

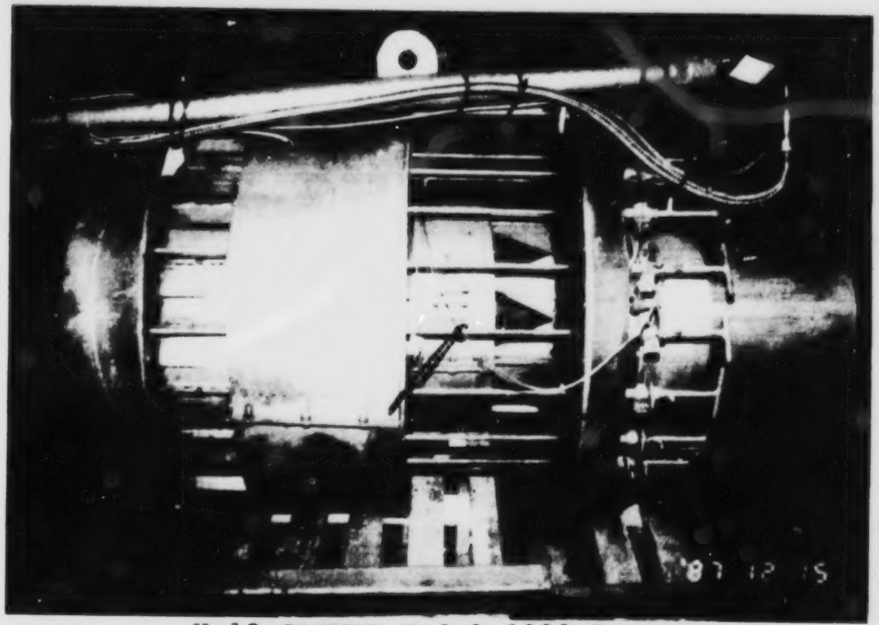


H-9:Modification for side viewport

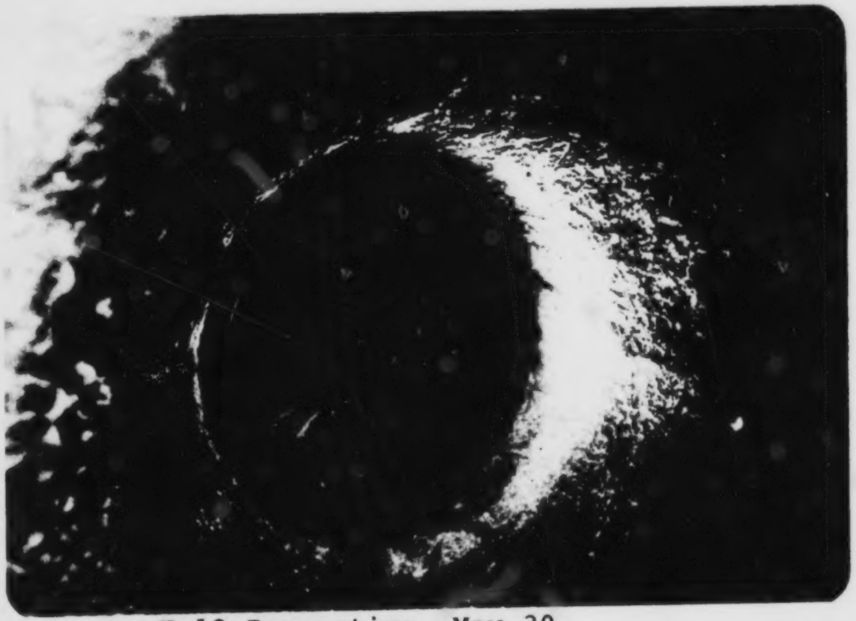
H-10:Modifications to frontwall



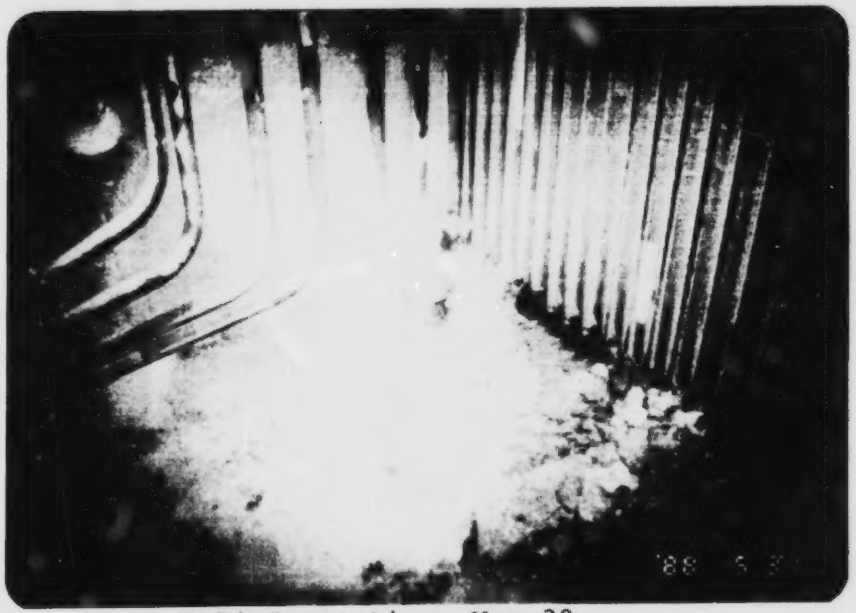
H-11:Boiler installation



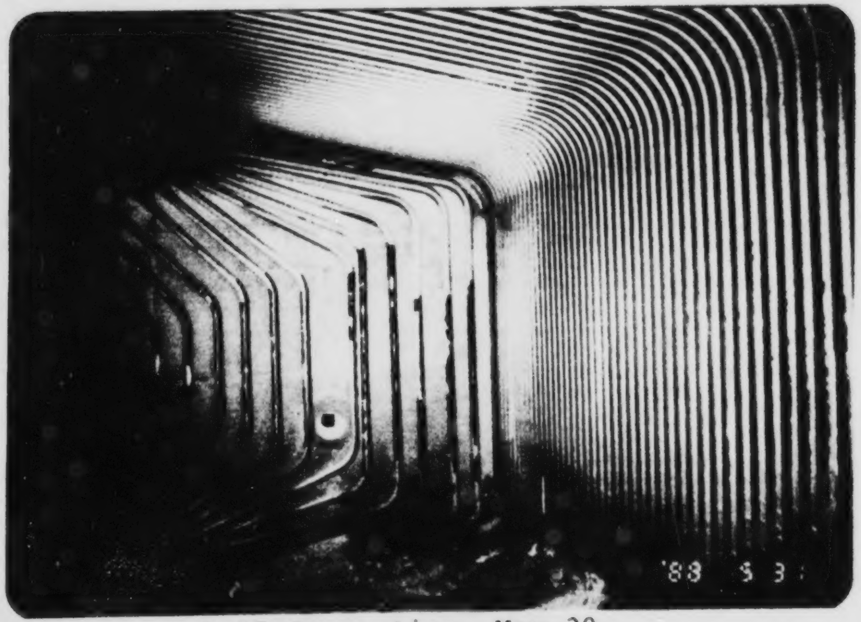
H-12:CANMET Model 1000 Burner



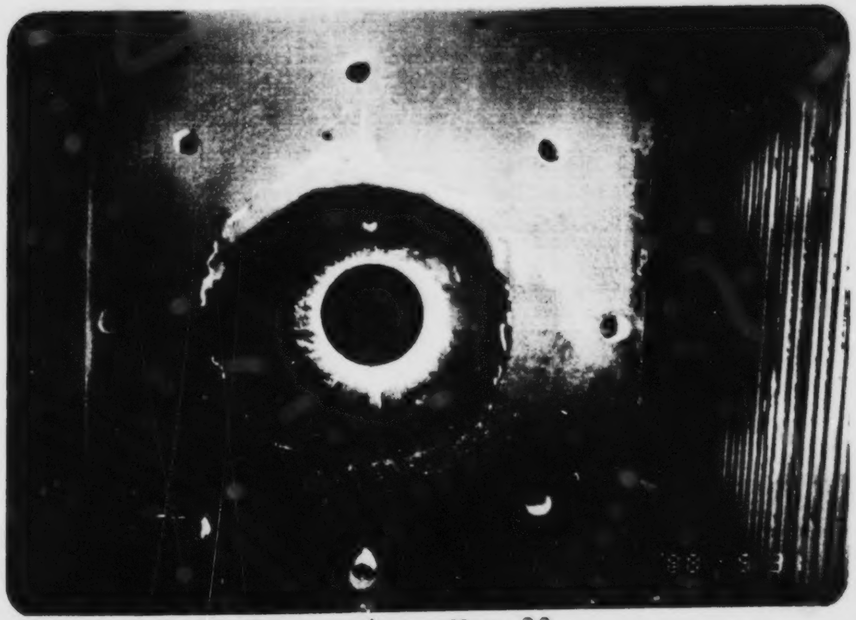
H-13:Inspection, May 30
Refractory quarl



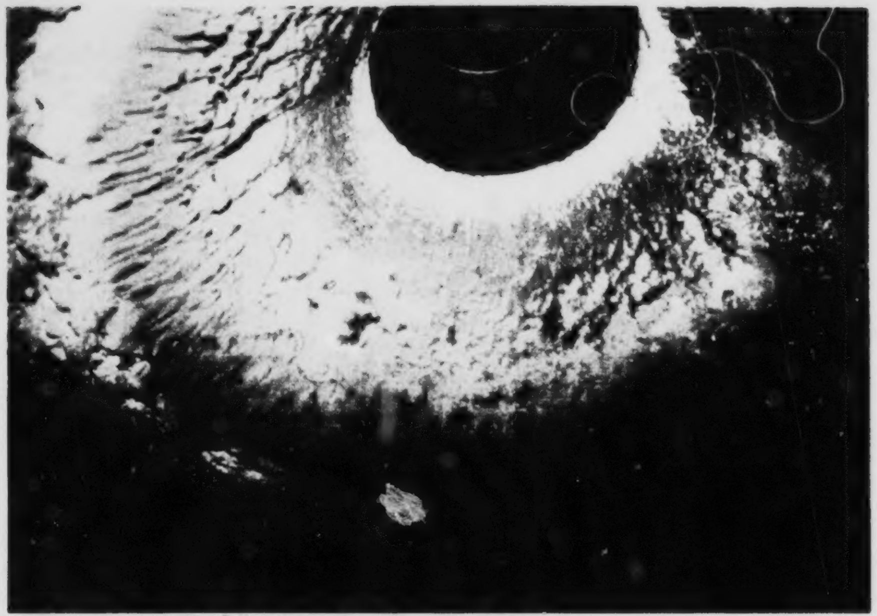
H-14:Inspection, May 30
Furnace bottom



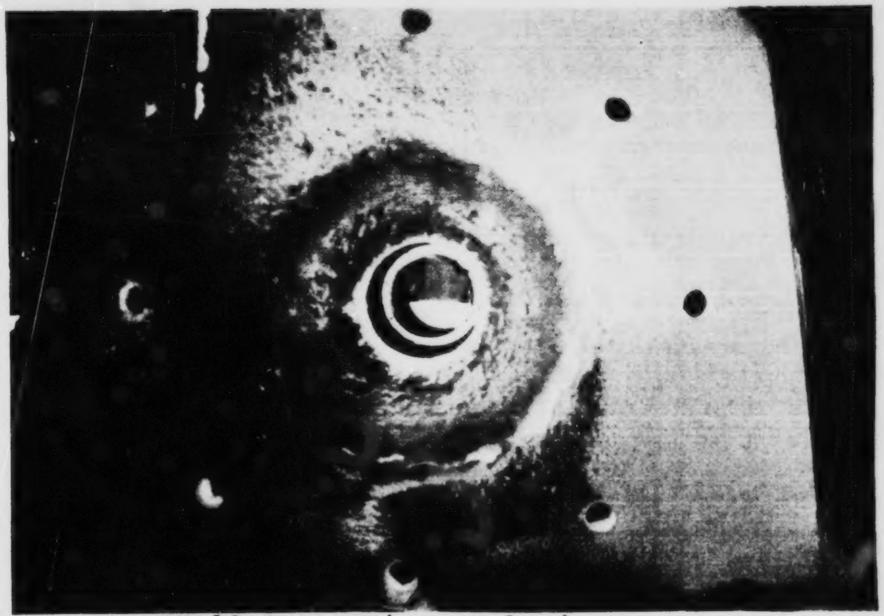
H-15:Inspection, May 30
Furnace interior



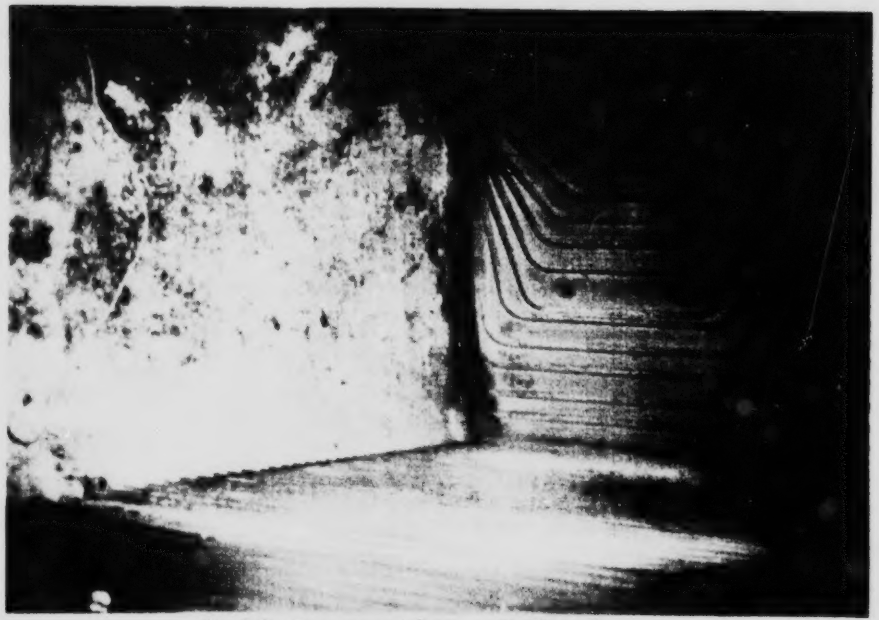
H-16:Inspection, May 30
Tertiary airport installation



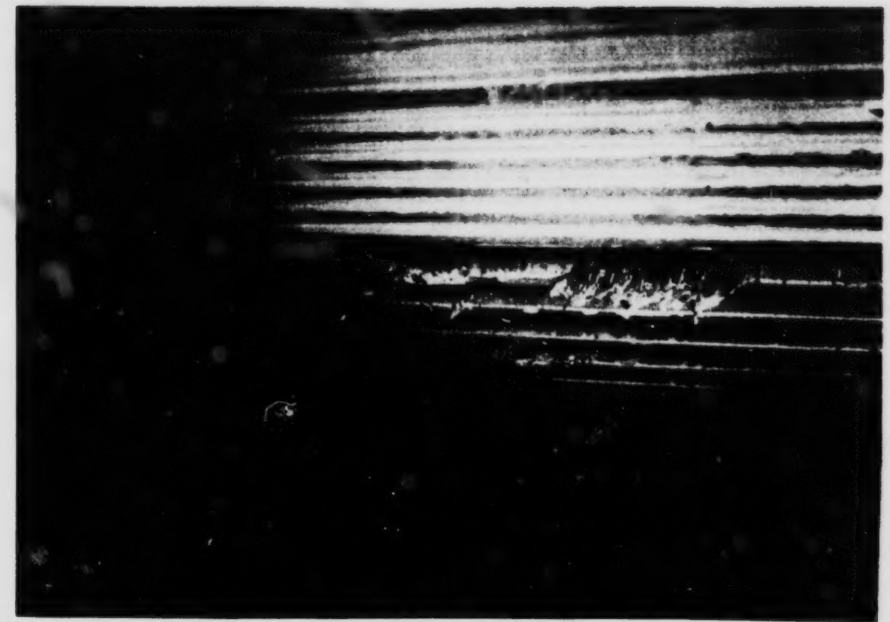
H-17:Inspection, July 4
Refractory quarl



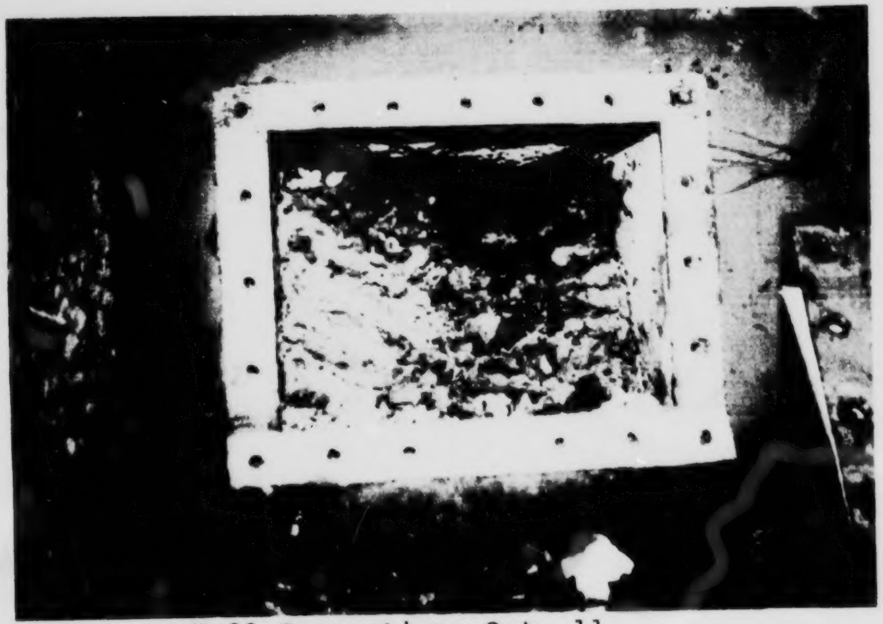
H-18:Inspection, July 4
Boiler frontwall



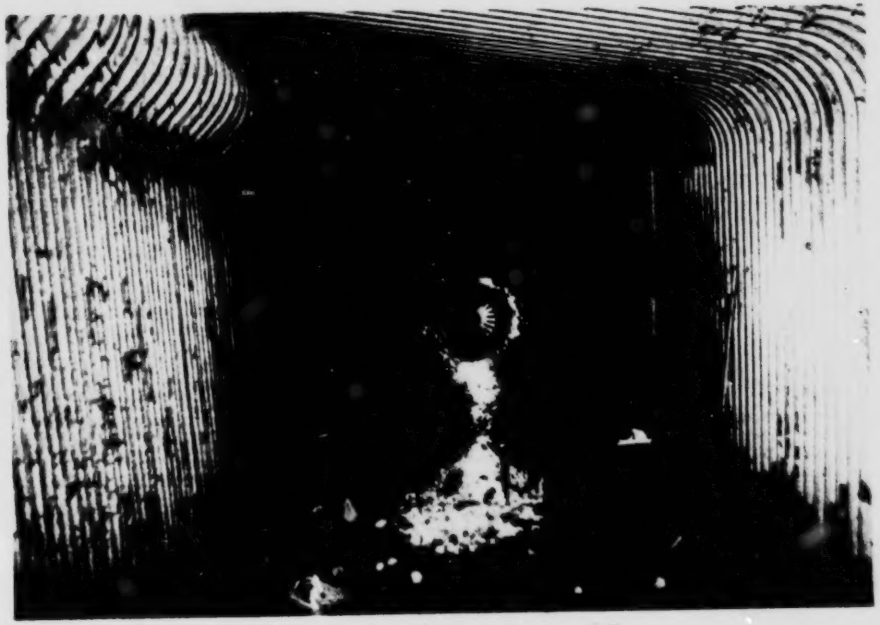
H-19:Inspection, July 4
Furnace interior



H-20:Inspection, July 4
Floor and gaspass entry

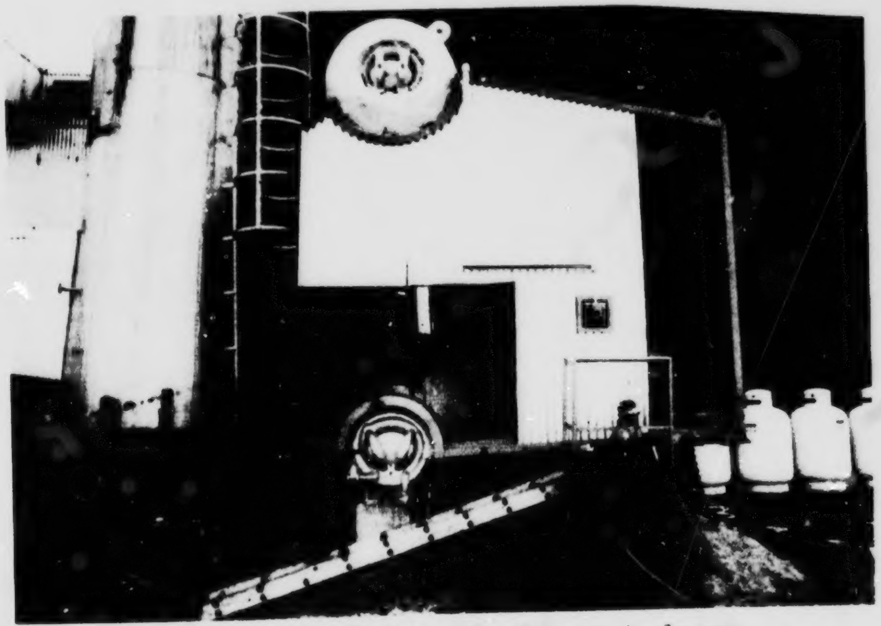


H-21:Inspection, Oct. 11
Manway entry to boiler



H-22:Inspection, Oct. 11
Boiler interior

H-23:Inspection, Oct. 11
Gaspass entry



H-24:Addition of cleanout doors
at boiler rear

APPENDIX I

OPERATOR LOG SHEETS

SHIFT OPERATOR LOG - BOILER #7: Operation with Coal-Water Fuel at Minas Basin Pulp and Power

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
May 01	1																							
	2																							
	3																							
May 02	1																							
	2																							
	3																							
May 03	1																							
	2																							
	3																							
May 04	1																							
	2																							
	3																							
May 05	1																							
	2																							
	3																							
May 06	1																							
	2																							
	3																							
May 07	1																							
	2																							
	3																							
May 08	1																							
	2																							
	3																							
May 09	1																							
	2																							
	3																							
May 10	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
May 11	1																							
	2																							
	3																							
May 12	1																							
	2																							
	3																							
May 13	1																							
	2																							
	3																							
May 14	1																							
	2																							
	3																							
May 15	1																							
	2																							
	3																							
May 16	1																							
	2																							
	3																							
May 17	1																							
	2																							
	3																							
May 18	1																							
	2																							
	3																							
May 19	1																							
	2																							
	3																							
May 20	1																							
	2																							
	3																							

2

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
May 21	1																							
	2																							
	3																							
May 22	1																							
	2																							
	3																							
May 23	1																							
	2																							
	3																							
May 24	1																							
	2																							
	3																							
May 25	1																							
	2																							
	3	34600	CWF	2595	43300	1.48	4.7		-1.25	517	291	7.0	70	6.00	3.00		16.00	140	113		207	160	0	0.0
May 26	1	35800	CWF	3499	38600	1.58	5.2		-1.51	505	288	5.9	70	5.75	6.50		15.75	120	107	8	207	193	1.3	0.0
	2	26100	CWF	2649	24200	1.61	4.9		-1.67	437	268	3.0	65	4.50	7.00		16.00	95	78	88	221	208	2.4	0.0
	3	31300	CWF	3430	37400	1.50	4.8		-1.32	496	287	4.5	65	6.00	6.00		16.00	100	95	106	190	203	0.8	
May 27	1	[illegible]500	CWF	3577	35600	1.58	4.4		-1.43	485	288	2.5	65	6.00	6.00		16.00	112	88	101	206	188	2.7	0.0
	2																							
	3																							
May 28	1																							
	2																							
	3																							
May 29	1																							
	2																							
	3																							
May 30	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
May 31	1																							
	2																							
	3																							

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
May 01	1																							
	2																							
	3																							
May 02	1																							
	2																							
	3																							
May 03	1																							
	2																							
	3																							
May 04	1																							
	2																							
	3																							
May 05	1																							
	2																							
	3																							
May 06	1																							
	2																							
	3																							
May 07	1																							
	2																							
	3																							
May 08	1																							
	2																							
	3																							
May 09	1																							
	2																							
	3																							
May 10	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/RFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
May 11	1																							
	2																							
	3																							
May 12	1																							
	2																							
	3																							
May 13	1																							
	2																							
	3																							
May 14	1																							
	2																							
	3																							
May 15	1																							
	2																							
	3																							
May 16	1																							
	2																							
	3																							
May 17	1																							
	2																							
	3																							
May 18	1																							
	2																							
	3																							
May 19	1																							
	2																							
	3																							
May 20	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
May 21	1																							
	2																							
	3																							
May 22	1																							
	2																							
	3																							
May 23	1																							
	2																							
	3																							
May 24	1																							
	2																							
	3																							
May 25	1																							
	2																							
	3		CWF																					
May 26	1		CWF																					
	2		CWF																					
	3		CWF																					
May 27	1		CWF																					
	2																							
	3																							
May 28	1																							
	2																							
	3																							
May 29	1																							
	2																							
	3																							
May 30	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
May 31	1																							
	2																							
	3																							

SHIFT OPERATOR LOG - BOILER #7: Operation with Coal-Water Fuel at Minas Basin Pulp and Power

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/BFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Jun 01	1																							
	2																							
	3	21000	CWF	2510	32800	17.00	4.1		-0.65	413	256	2.6	65	6.00	6.00		15.75	107	90	97	213	96	0.25	
Jun 02	1	21700	CWF	2533	26400	17.00	3.9		-0.50	418	254	2.8	65	6.00	6.00		15.75	98	82	93	210	95	0.00	
	2	26400	CWF	2753	39300	1.50	5.0		-2.14	435	261	2.2	65	6.00	6.00		15.75	112	96	101	203	196	1.20	
	3	32000	CWF	3507	35900	1.50	5.4		-1.11	467	283	4.4	65	5.75	6.50		15.75	124	107	122	206	186	0.40	
Jun 03	1	29200	CWF	3191	35900	1.20	4.9		-1.11	463	277	4.8	65	5.75	6.50		15.75	125	104	128	204	190	0.40	
	2	29600	CWF	3069	41200	1.40	4.7		-1.31	456	269	3.8	65	6.00	6.10		15.75	122	103	111	202	166	0.00	
	3	29800	CWF	3257	34500	1.51	4.8		-1.54	468	283	4.2	65	6.00	6.10		15.75	123	106	117	208	191	0.00	
Jun 04	1	29300	CWF	3280	36000	1.55	5.0		-1.75	471	280	4.5	65	5.80	6.30		15.75	124	104	114	205	175	0.00	
	2	29200	CWF	3314	34200	1.55	5.0		-1.57	475	285	3.9	65	6.00	6.00		16.00	122	105	115	203	182	0.00	
	3	30900	CWF	3243	35900	1.55	5.5		-1.99	467	273	4.0	65	5.90	6.30		15.90	129	113	120	204	189	0.00	
Jun 05	1	32700	CWF	3114	30200	1.54	4.3		-2.36	465	273	3.0	65	5.75	6.50		15.75	125	105	115	210	185	5.00	
	2	25400	CWF	2442	27600	1.54	4.5		-1.88	429	266	4.5	65	5.75	6.50		15.75	124	96	105	205	202	0.00	
	3	22900	CWF	2625	35300	1.54	4.2		-0.96	439	269	2.0	65	5.75	6.50		15.75	120	96	107	205	205	2.50	
Jun 06	1	23500	CWF	2479	32400	1.55	4.9		-1.71	428	264	2.6	65	5.75	6.50		15.75	117	94	104	211	205	0.00	
	2	25900	CWF	2720	30000	1.56	5.3		-1.94	446	274	3.1	65	5.75	6.50		15.75	124	107	117	203	188	0.00	
	3	28400	CWF	3048	37100	1.56	4.1		-3.68	465	280	5.0	65	5.75	6.50		15.75	126	111	120	200	170	0.00	
Jun 07	1	32200	CWF	3468	30200	1.56	5.2		-0.71	491	285	3.8	65	5.75	6.50		15.75	135	120	132	202	180	0.00	
	2	26000	CWF	2619	27600	1.49	4.9		-1.17	447	271	4.1	65	5.75	6.50		15.75	125	111	120	206	185	0.00	
	3	23000	CWF	2303	29800	1.40	5.8		-2.31	420	264	2.0	65	5.75	6.50		15.75	85	61	73	208	180	0.00	
Jun 08	1	23900	CWF	2504	31300	1.40	4.1		-2.02	435	268	2.8	65	5.75	6.50		15.75	90	66	75	208	175	0.00	
	2	25100	CWF	2548	27700	1.40	5.2		-0.98	436	272	4.0	65	5.75	6.50		15.75	87	65	75	204	185	0.00	
	3	35300	CWF	3831	39000	1.49	4.7		-0.29	519	298	4.6	65	5.75	6.50		15.75	109	89	100	208	170	0.00	
Jun 09	1	35500	CWF	3826	36100		4.2		-0.98	507	292	4.5	65	5.75	6.50		15.75	110	89	101	210	190	0.00	
	2	28100	CWF	2976	29400	1.01	5.3		-1.01	466	282	3.8	65	5.75	6.50		15.75	92	73	79	205	191	1.40	
	3	25800	CWF	2519	26100	1.05	5.4		-1.27	435	272	2.5	65	5.75	6.50		15.75	93	69	77	209	187	0.00	
Jun 10	1	25400	CWF	2783	31200	1.00	4.9		-1.10	455	274	2.8	65	5.75	6.50		15.75	99	73	81	208	185	0.00	
	2	27400	CWF	2854	36700	1.02	3.8		-0.98	456	277	2.6	65	5.75	6.50		15.75	101	76	86	207	178	0.00	
	3	28900	CWF	2976	35000	1.02	4.6		-0.90	465	281	3.0	65	5.75	6.50		15.75	100	76	86	210	193	0.00	

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Jun 11	1	29000	CWF	3243	29900		4.3		-0.99	476	284	3.5	65	5.75	6.50		15.75	106	79	87	205	190	0.00	
	2	31000	CWF	3088	32200		5.3		-0.79	485	291	4.0	65	5.75	6.50		15.75	104	76	85	205	178	0.00	
	3	26500	CWF	2812	26300		6.1		-1.31	446	281	3.0	65	5.75	6.50		15.75	100	73	80	205	180	0.00	
Jun 12	1	24700	CWF	2569	33700		4.2		-0.91	449	273	2.5	65	5.75	6.50		15.75	107	79	87	212	176	0.00	
	2	24200	CWF	2509	22000		4.3		-0.93	455	280	2.3	65	5.75	6.50		15.75	106	80	91	208	180	0.00	
	3	26600	CWF	2621	25500		4.2		-1.16	463	280	3.0	65	5.75	6.50		15.75	110	84	94	210	180	0.00	
Jun 13	1	29400	CWF	2601	20900		5.0		-0.95	477	283	3.3	65	5.75	6.50		15.75	108	84	90	205	183	0.00	
	2	28700	CWF	2783	27600	0.99	4.3		-0.95	473	286	2.0	65	5.75	6.50		15.75	108	85	95	210	180	0.00	
	3	26400	CWF	3005	27100	0.99	4.6		-0.89	491	296	3.4	65	5.75	6.50		15.75	105	84	95	205	172	0.50	
Jun 14	1	30600	CWF	3302	32500	0.98	5.2		-1.12	498	289	4.1	65	5.75	6.50		15.75	115	93	103	203	181	0.00	
	2	23500	CWF	2456	17800	0.98	4.8		-0.55	441	273	1.6	65	5.75	6.50		15.75	90	65	73	205	189	0.00	
	3	24800	CWF	2585	22000	1.00	5.9		-1.56	455	278	2.5	65	5.75	6.50		15.75	95	67	78	206	185	0.00	
Jun 15	1	29100	CWF	3074	20500		4.5		-1.11	497	287	3.4	65	5.75	6.50		15.75	103	77	84	209	189	0.00	
	2	21100	CWF	2098	13200	1.28	5.0		-0.36	419	273	3.5	65	5.75	6.50		15.75	95	68	76	210	200	0.00	
	3	26600	CWF	2710	20500	0.98	7.0		-1.38	466	286	4.0	65	5.75	6.50		15.75	102	74	83	205	200	0.00	
Jun 16	1	30000	CWF	3008	29000	0.98	4.1		-1.06	492	287	2.0	65	5.75	6.50		15.75	105	76	84	210	200	0.00	
	2																							
	3	23800	CWF	2919	20000		5.8		-1.28	479	289	3.8	65	5.75	6.50		15.75	106	93	102	205	168	0.00	
Jun 17	1	27900	CWF	3148	30200		5.0		-0.87	471	284	4.0	65	5.75	6.50		15.75	115	90	96	210	167	0.00	
	2	27900	CWF	3130	28100		5.8		-1.28	479	289	3.8	65	5.75	6.50		15.75	106	92	102	205	168	0.00	
	3		HFO																					
Jun 18	1	24800	CWF	2599	29900	1.30	5.1		-1.09	444	273	3.2	65	5.75	6.50	1	15.75	118	85		205	180	0.00	
	2	24200	CWF	2599	28700	1.30	4.2		-1.18	438	271	3.4	65	5.75	6.50	1	15.75	119	81		210	183	0.00	
	3	23200	CWF	2283	26600	1.45	4.9		-1.06	422	266	2.2	65	5.75	6.50	1	15.75	101	81		203	181	0.00	
Jun 19	1	22500	CWF	2223	29800	1.46	4.8		-2.04	430	270	2.6	65	5.75	6.50	1	15.75	111	77		208	177	0.00	
	2	20100	CWF	2051	23600	1.46	4.7		-0.92	425	269	2.3	65	5.75	6.50	1	15.75	99	78		204	175	0.00	
	3	18400	CWF	1848	19300	1.46	6.1		-0.84	415	267	2.1	65	5.75	6.50	1	15.75	108	73		206	185	0.00	
Jun 20	1	20300	CWF	1996	23100	1.46	6.5		-0.99	419	262	1.9	65	5.75	6.50	1	15.75	115	75		204	185	0.00	
	2	25700	CWF	2885	18100	1.46	4.4		-1.91	473	284	3.5	65	5.75	6.50	1	15.75	99	78		205	175	0.00	
	3	26500	CWF	2585	6800		5.3		-1.00	460	283	2.8	65	5.75	6.50	1	15.75	103	72		208	177	0.67	

2

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift	(lb/hr)	(CWF/NFO)	(lb/hr)	(lb/hr)																			
Jun 21	1	25100	CWF	2746	18900		5.1		-1.09	474	282	3.0	65	5.75	6.50	1	15.75	111	83		211	172	0.67	
	2	23300	CWF	2629	23600	21.00	6.2		-0.97	470	286	3.4	65	5.75	6.50	1	15.75	102	79		206	195	0.40	
	3	19300	CWF	1937	12300		5.8		-0.86	424	274	2.0	65	5.75	6.50	1	15.75	98	67		209	197	3.50	
Jun 22	1	21900	CWF	2142	21000		4.3		-1.07	431	272	2.0	65	5.75	6.50	1	15.75	99	71		205	185	0.90	
	2	20300	CWF	2041	9600	17.00	7.1		-0.97	453	282	2.9	65	5.75	6.50	1 / 2	15.75	90	78		201	191	0.50	
	3	21500	CWF	2302	6900	13.00	5.3		-0.95	447	276	2.5	65	5.75	6.50	2	15.75	97	79		203	186	0.00	
Jun 23	1	22300	CWF	2271	21400	17.00	6.6		-1.16	457	275	2.8	65	5.75	6.50	2	15.75	105	77		208	195	0.00	
	2	18200	CWF	1978	22500	10.00	5.5		-1.08	326	259	2.0	65	5.75	6.50	1	15.75	104	73		210	140	0.00	
	3	20100	CWF	2112	20500	11.00	5.2		-0.93	427	272	2.0	65	5.75	6.50	1	15.75	104	84		205	190	0.00	
Jun 24	1	31800	CWF	2948	33900		4.2		-1.34	482	283	2.8	65	5.75	6.50	1	15.75	110	89		210	188	0.00	
	2	23400	CWF	2788	24100		3.5		-1.27	480	290	3.0	65	5.75	6.50	1	15.75	107	78		210	190	0.00	
	3	26200	CWF	2622	29900	19.00	5.8		-0.84	483	286	3.0	65	5.75	6.50	1	15.75	109	78		204	179	1.00	
Jun 25	1	30000	CWF	3154	33500	27.00	5.7		-0.90	497	284	3.5	65	5.75	6.50	1	15.75	113	86		210	170	0.00	
	2	25000	CWF/NFO	2746	23800	23.00	6.0		-0.87	468	282	3.8	65	5.75	6.50	2	15.75	101	81		208	170	0.00	
	3	22700	CWF	2528	27000	23.00	5.6		-0.92	457	274	2.5	65	5.75	6.50	2	15.75	118	81		210	175	0.00	
Jun 26	1	29000	CWF	3177	26200	21.00	3.9		-0.95	484	279	3.1	65	5.75	6.50	2	15.75	112	81		201	170	0.00	
	2	25600	CWF	2973	24700	21.00	5.5		-1.22	476	277	3.0	65	5.75	6.50	2	15.75	98	68		206	169	0.00	
	3	22600	CWF	2516	24700	19.00	5.6		-1.11	437	267	2.0	65	5.75	6.50	2	15.75	100	70		210	170	0.00	
Jun 27	1	20200	CWF	1572	25800	5.00	5.5		-1.20	383	229	3.0	65	5.75	6.50	2	15.75	96			205	174	0.00	
	2	19500	CWF/NFO	2409	22300	5.00	4.1		-0.73	404	259	2.0	65	5.75	6.50	1	15.75	60	38		200	170	0.00	
	3	23200	CWF/NFO	2587	34300	21.00	5.7		-0.97	438	262	2.8	65	5.75	6.50	1	15.75	88			206	188	2.00	
Jun 28	1	27000	CWF	2972	33800	23.00	4.6		-1.07	465	279	3.0	65	5.75	6.50	1	15.75	98	65		208	168	0.00	
	2	23300	CWF	2535	33400		5.6		-1.05	395	271	2.8	65	5.75	6.50	1	15.75	88	55		210	178	0.00	3.0
	3	23800	CWF	2544	23700	18.00	5.6		-0.97	447	273	3.0	65	5.75	6.50	2	15.75	99	73		205	177	0.00	
Jun 29	1	26900	CWF	3031	29600	24.00	5.2		-0.89	481	282	3.5	65	5.75	6.50	2	15.75	117	86		208	170	0.00	
	2	22700	CWF	2403	23400	18.00	5.5		-1.00	435	269	2.5	65	5.75	6.50	2	15.75	103	66		206	167	0.00	
	3	25200	CWF	2720	26100	19.00	5.4		-1.02	463	278	3.0	65	5.75	6.50	1	15.75	98	68		210	180	0.00	
Jun 30	1	27400	CWF	2985	28600	21.00	5.1		-1.00	470	277	3.1	65	5.75	6.50	1	15.75	93	72		205	179	0.00	
	2	25600	CWF	2673	26900	19.00	4.8		-0.94	453	275	3.0	65	5.75	6.50	1	15.75	101	70		203	183	0.00	
	3	27400	CWF	3048	26500	21.00	5.9		-1.02	471	283	3.5	65	5.75	6.50	2	15.75	97	69		207	188	0.00	

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec Damp.	Gun ID	Gun Pos	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)		(%)	(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Jun 01	1																							
	2																							
	3		CWF																					
Jun 02	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 03	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 04	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 05	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 06	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 07	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 08	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 09	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 10	1		CWF																					
	2		CWF																					
	3		CWF																					

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Jun 11	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 12	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 13	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 14	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 15	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 16	1		CWF																					
	2																							
	3		CWF																					
Jun 17	1		CWF																					
	2		CWF																					
	3	20800	HFO	1394	18500		4.5		-1.09	415	263	2.5	65	5.75	6.50		15.75	112	90	98	205	170	0	
Jun 18	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 19	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 20	1		CWF																					
	2		CWF																					
	3		CWF																					

5

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Jun 21	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 22	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 23	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 24	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 25	1		CWF																					
	2	24100	HFO/CWF	1690	18300	17.00	5.5		-1.08	456	261	2.0	65	6.50	5.75	2	15.75	110			205	180	0	
	3		CWF																					
Jun 26	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 27	1																							
	2	25400	HFO/CWF	1986	39600	22.00	6.3		-0.98	461	264		65	5.75	6.50	1	15.75	80	70		210	170	0	
	3	27700	HFO/CWF	2065	37700		6.8		-0.91	479	276	4.0	65	5.75	6.50	1	15.75	85	52		202	168	1	
Jun 28	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 29	1		CWF																					
	2		CWF																					
	3		CWF																					
Jun 30	1		CWF																					
	2		CWF																					
	3		CWF																					

6

SHIFT OPERATOR LOG - BOILER #7: Operation with Coal-Water Fuel at Minas Basin Pulp and Power

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Jul 01	1																							
	2																							
	3																							
Jul 02	1																							
	2																							
	3																							
Jul 03	1																							
	2																							
	3																							
Jul 04	1																							
	2																							
	3																							
Jul 05	1																							
	2																							
	3																							
Jul 06	1																							
	2																							
	3	34500	CWF	4057	36500	29.00	5.14	897	-1.13	519	301	4.8	65	5.75	5.50	1	15.25	130	112		208	123	0.00	
Jul 07	1	33500	CWF	3840	37100	28.00	4.77		-1.03	505	295	4.0	65	5.75	5.50	1	15.25	125	97		209	126	0.00	
	2	33600	CWF	3638	34500	30.00	5.5	857	-0.98	489	290	3.8	60	5.75	6.25	1 / 2	15.25	122	98		210	136	1.10	
	3	27500	CWF	3010	29500	20.00	4.69	859	-1.02	457	280	3.0	60	5.75	6.25	2	15.25	125	103		209	150	0.00	
Jul 08	1	27500	CWF	3047	30000	21.00	4.85	860	-1.10	462	278	3.0	60	5.75	6.25	2	15.25	121	91		208	147	0.00	
	2	27500	CWF	2939	27800	21.00	5.41	846	-0.95	467	284	3.0	60	5.75	6.25	1	15.75	130	107		209	150		
	3	31800	CWF	3179	30000	24.00	5.44	855	-0.97	487	291	3.0	60	5.75	6.25	1	15.75	124	101		202	157	1.75	
Jul 09	1	33100	CWF	3353	31900	22.00	5.51	872	-1.05	491	291	3.6	60	5.75	6.25	1	15.75	119	93		203	144		
	2																							
	3																							
Jul 10	1																							
	2																							
	3																							

7

Parameter Date	Parameter Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Jul 11	1																							
	2	27300	CWF/HFO	2859	26900	22.00	6.4	926	-1.17	470	285	2.0	60	5.75	6.25	1	15.75	110	74		210	160		
	3	30100	CWF	3266	24700	21.00	3.75	894	-1.06	449	285	2.8	60	5.75	6.50	2	15.25	134	108		211	128	0.40	
Jul 12	1	27100	CWF	3075	25300	18.00	3.44	907	-1.02	449	278	2.5	60	5.75	6.50	2	15.25	129	101		210		0.00	
	2	27800	CWF/HFO	2671	23300	20.00	5.6	823	-1.10	439	251	2.0	55	5.75	6.50	2	15.75	120	86		210	126	0.00	
	3	21900	CWF	2441	19100		3.85	831	-1.09	424	275	1.6	60	5.75	6.50	2	15.25	122	90		208	133	0.17	
Jul 13	1	24300	CWF	2489	22300	2.20	3.65	845	-0.98	427	272	1.7	60	5.75	65.00	2	15.25	120	89		209		0.00	
	2	24700	CWF	2937	26400		4.23	820	-1.19	441	283	2.1	60	5.75	6.50	2	15.25	131	96		209	133	0.00	
	3	32200	CWF	3394	31500		4.8	844	-0.87	487	292	2.8	60	5.75	6.50	2	15.25	127	97		208	138	0.00	
Jul 14	1		HFO																					
	2	11800	CWF/HFO	1475	28100		9	527	-1.15	370	249	1.5	50	7.00	5.75	2	15.25	83	48		207	180	0.00	
	3		HFO																					
Jul 15	1		HFO																					
	2		HFO																					
	3		HFO																					
Jul 16	1																							
	2																							
	3																							
Jul 17	1																							
	2																							
	3																							
Jul 18	1																							
	2																							
	3		HFO																					
Jul 19	1		HFO																					
	2		HFO																					
	3	25200	CWF/HFO	2264	30800	0.56	6.5	679	-0.75	458	270	2	60	5.75	6.5	2	15.5	75	45		210	80	0	
Jul 20	1		HFO																					
	2	21400	CWF/HFO	2245	25300	2.00	6.4	806	-0.72	502	260	1.5	65	5.75	6.50	2	15.25	120	92		210	154	0.00	
	3		HFO																					

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)																
Jul 21	1		HFO																					
	2		HFO																					
	3		HFO																					
Jul 22	1		HFO																					
	2	26100	CWF/HFO	2602	28000	0.67		926	-0.89	567	286	3.0	60	5.75	6.50	2	15.25	145	116	0	210	144	0.00	
	3	26000	CWF/HFO	2752	26700			893	-0.80	515	271	1.0	60	5.75	6.50	1	15.25	110	70		210	130	0.00	
Jul 23	1		HFO																					
	2																							
	3																							
Jul 24	1																							
	2																							
	3																							
Jul 25	1																							
	2		HFO																					
	3																							
Jul 26	1																							
	2																							
	3	29900	CWF	3193	32800			1136	-1.07	583	290	2.5	60	5.75	6.50	2	17.00	145	84		210	148	0.00	
Jul 27	1	30600	CWF/HFO	3288	34400			1197	-1.02	578	287	2.0	60	5.75	6.50	2	17.00	150	76		208	168	0.00	
	2	32500	CWF/HFO	3679	51100			1207	-0.79	613	306	5.0	50	6.50	7.00	2	17.00	150	72		210	160	0.00	
	3		HFO																					
Jul 28	1		HFO																					
	2		HFO																					
	3	26100	CWF	2831	33000			859	-1.04	569	283	2.0	60	5.75	6.50	1 / 2	17.00	119	73		208	145	0.00	
Jul 29	1	25300	CWF	2821	33200	18.00		914	-1.01	568	281	2.0	50	5.75	6.50	2	17.00	121	66		206	144	0.00	
	2	35300	CWF	2737	33500			915	-1.09	566	280	2.0	50	5.75	6.50	1 / 2	17.00	123	70		208	144	0.00	
	3		HFO																					
Jul 30	1		HFO																					
	2																							
	3																							

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Jul 31	1																							
	2																							
	3																							

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Jul 01	1																							
	2																							
	3																							
Jul 02	1																							
	2																							
	3																							
Jul 03	1																							
	2																							
	3																							
Jul 04	1																							
	2																							
	3																							
Jul 05	1																							
	2																							
	3																							
Jul 06	1																							
	2																							
	3		CWF																					
Jul 07	1		CWF																					
	2		CWF																					
	3		CWF																					
Jul 08	1		CWF																					
	2		CWF																					
	3		CWF																					
Jul 09	1		CWF																					
	2																							
	3																							
Jul 10	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CMF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Jul 11	1		CMF																					
	2	24000	HFO/CMF	1654	20000	20.00	6.8	674	-1.06	439	264	3.5	60	5.75	6.25	1	15.75	135	103		211	134	0	
	3																							
Jul 12	1		CMF																					
	2	24300	HFO/CMF	1916	27900	22.00	5.4	560	-1.10	427	311	2.0	60	5.75	6.50	2	15.25	86	50		210	152	0	
	3		CMF																					
Jul 13	1		CMF																					
	2		CMF																					
	3		CMF																					
Jul 14	1	20900	HFO		31700	8.00	7.1		-0.92	410	259	1.0	60	6.00	7.00	2	15.25	100	60		210	160	0	
	2	27400	HFO/CMF	1661	26300		4.4	614	-0.70	447	272	2.0	50	7.00	5.75	2	15.25	113	71		210	149	0	
	3	[illegible]2800	HFO	1440	25900	0.44	5.75	590	-1.05	452	276	1.8	50	7.00	5.75	2	15.25	103	64		209	155	0	
Jul 15	1	22100	HFO	1526	29600	0.48	6.2		-0.89	468	277	1.2	50	7.00	5.75	2	15.25	104	64		207	158	0	
	2	22800	HFO	1606	29900	0.52	7.4	598	-0.92	492	293	2.5	50	7.00	5.75	2	15.25	108	68		208	153	0	
	3	25600	HFO	1778	31800	0.52	6.26	516	-1.26	536	302	1.7	50	7.00	5.75	2	15.25	96	69		209	149	0	
Jul 16	1																							
	2																							
	3																							
Jul 17	1																							
	2																							
	3																							
Jul 18	1																							
	2																							
	3	23900	HFO	1720	29600	0.58	4.78	533	-1.02	446	276	2.3	50	6.00	6.00	2	15.50	150	120		210	93	0	
Jul 19	1	30000	HFO	2162	34900	0.58	5.34	497	-1.27	525	303	2.6	50	6.00	6.00	2	15.50	151	126		210	110	0	
	2	33500	HFO	2421	40500	26.00	5.29	462	-0.63	569	317	4.0	60	5.75	6.50	2	15.50	148	120		210	110	0	
	3	23300	HFO/CMF	1624	30400	0.22	5	556	-1.08	478	281	1.5	60	5.75	6.50	2	15.50	143	113		210	124	0	
Jul 20	1	34200	HFO	2253	35400	0.55	5.5	529	-1.01	579	338	3.4	60	5.75	6.50	2	15.50	145	119					
	2	30400	HFO/CMF	1969	31800	21.00	6.4	567	-0.96	551	316	2.3	60	5.75	6.50	2	15.00	144	115		207	173	0	
	3	26700	HFO	1867	29800	0.57		585	-0.97	546	294	2.9	65	5.75	6.50	2	15.25	143	110	0	210	98	0	

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Jul 21	1	26600	HFO	1849	30800	0.54		579	-1.07	560	305	3.0	65	5.75	605.00	2	15.25	142	112		210	110	0	
	2	25700	HFO	1857	27900		0.5456	577	-0.93	556	301	2.8	60	5.75	6.50	2	15.25	144	112		209	131	0	
	3	25400	HFO	1828	25500	0.65		576	-1.12	559	313	2.1	60	5.75	6.50	2	15.25	147	115	0	209	118	0	
Jul 22	1	27300	HFO	1953	32200	0.68		555	-1.16	579	329	3.8	60	5.75	6.50	2	15.25	147	117		210	119	0	
	2	26800	HFO/CWF	1963	33300	0.84		561	-1.13	582	321	3.3	60	5.75	6.50	2	15.25	147	116	0	208	125	0	
	3	26200	HFO/CWF	1882	41400			458	-1.25	578	293	4.0	60	5.75	6.50	1	15.25	75	42		210	120	0	
Jul 23	1	28100	HFO	1957	36400	0.76		435	-1.12	595	311	3.2	60	5.75	6.50	1	15.25	69	39		210	121	0	
	2																							
	3																							
Jul 24	1																							
	2																							
	3																							
Jul 25	1																							
	2	25900	HFO	1915	36600	0.96		614	-0.86	614	321	2.3	60	5.83	5.30	1	16.00	135	100		211	127	0	
	3																							
Jul 26	1																							
	2																							
	3		CWF																					
Jul 27	1	32900	HFO/CWF	2189	31200			559	-1.32	567	272	2.0	60	5.75	6.50	2	17.00	145	114		210	164	0	
	2	26600	HFO/CWF	1799	34000	0.88		472	-1.07	576	281	3.7	50	6.00	6.50	1	17.00	89	48		210	171	0	
	3	29800	HFO	1956	36000			370	-1.06	587	294	4.0	50	6.00	2.00	2	17.00	82	43		207	172	0	
Jul 28	1	27600	HFO	1834	39800	30.00		365	-1.06	584	288	4.0	50	5.75	3.25	2	17.00	80	41		205	176	0.13	
	2	32500	HFO	2228	41700	1.06		387	-1.07	602	303	4.4	50	5.75	3.25	2	17.00	83	45		210	128	0	
	3		CWF																					
Jul 29	1		CWF																					
	2		CWF																					
	3	17800	HFO	1269.0	45100	30.00		345.0	-1.00	559.0	269	4.1	50.0	5.8	6.5	1.0	17.00	74	40.0		210	181	0.0	
Jul 30	1	21600	HFO	1456.0	46200	30.00		370.0	-1.00	567.0	271	4.0	50.0	5.8	6.5	1.0	17.00	104	42.0		204	175	0.0	
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CMF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. P (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Jul 31	1																							
	2																							
	3																							

SHIFT OPERATOR LOG - BOILER #7: Operation with Coal-Water Fuel at Minas Basin Pulp and Power

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Aug 01	1																							
	2		HFO																					
	3	31500	CWF/HFO	3273	29300	21.00		970	-0.69	600	291	3.0	50	4.00	6.00	1	17.00	110	40		210	166		
Aug 02	1	30300	CWF/HFO	3230	34400	21.00		1053	-0.96	588	297	4.0	50	4.00	6.00	1	17.00	125	51		208	199	0.0	
	2	30400	CWF/HFO	3457	28000	16.00		819	-1.07	582	288	2.0	50	4.00	5.50	2	17.00	118	77		202	186	0.0	
	.3	29800	CWF	3255	26800	0.46		797	-1.05	576	284	2.8	50	4.00	5.50	1 / 2	17.00	118	73		210	189		
Aug 03	1		HFO																					
	2	32600	CWF/HFO	3408	37400	25.00		1114	-0.98	609	317	4.3	50	4.00	6.50	2	17.00	155	100		202	190	0.0	
	3	29600	CWF	3173	34400	0.80		1138	-1.02	590	297	4.0	50	4.00	6.50	2	17.00	153	97		207	196	0.0	
Aug 04	1	28000	CWF	2879	34600	0.74		1198	-1.03	573	283	2.5	50	4.00	6.50	1 / 2	17.00	150	100		203	203		
	2	28200	CWF	3012	29200	18.00		945	-0.87	570	280	2.6	50	4.00	6.50	1	17.00	131	82		203	189	0.0	
	3	26100	CWF	2958	22300	0.54		1035	-1.05	556	284	2.0	50	4.00	6.50	1	17.00	145	93		210	156	0.0	
Aug 05	1	29100	CWF	3196	35100	0.76		1020	-1.08	581	295	3.0	50	4.00	6.50	2	17.00	139	78		206	145	0.0	
	2	26700	CWF	2844	30500	18.06		1023	-0.99	575	291	2.6	50	5.10	6.50	2	17.00	135	78		203	163	0.0	
	3	24400	CWF	2592	25300	0.74		1005	-0.98	564	285	2.6	50	5.00	6.50	2	17.00	134	75		206	196	0.0	
Aug 06	1		HFO																					
	2																							
	3																							
Aug 07	1																							
	2																							
	3																							
Aug 08	1																							
	2		HFO																					
	3	27100	CWF/HFO	3317	33400	0.68		909	-0.71	583	287	3.0	50	6.00	5.00	1	17.00	125	83		210	130		
Aug 09	1	30000	CWF	3220	31800	0.64		1031	-1.09	572	290	2.4	50	6.00	5.00	1 / 2	17.00	137	81		209	136		
	2	32700	CWF	3582	35400	0.71		1102	-1.00	587	305	3.4	50	5.75	6.25	2	17.00	149	85		209	143	0.0	
	3	29900	CWF	3379	31300	0.71		1113	-0.94	583	301	2.8	50	5.75	6.25	2	17.00	149	82		210	143	0.0	
Aug 10	1	27400	CWF	2982	32200	0.71		1121	-0.73	569	290	2.6	50	5.75	6.25	2	17.00	146	70		210	155		
	2	30700	CWF	3294	29300	0.71		1122	-0.88	572	298	2.9	50	5.75	6.25	2	17.00	147	72		209	153	0.0	
	3	27000	CWF	2940	22600	0.62		1127	-1.10	562	292	2.0	50	5.75	6.25	2	17.00	147	66		210	164		

14

15

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Aug 11	1	30300	CWF	3084	28800	0.58		1123	-1.05	566	291	2.5	50	5.75	6.25	2	17.00	142	69		210			
	2	25600	CWF	2705	23800	0.58		1128	-0.90	561	291	2.5	50	5.75	6.25	2	17.00	145	69		210	160		
	3	28000	CWF	3029	23400	0.58		1124	-0.95	565	293	2.1	50	5.75	6.25	2	17.00	150	70		210	161		
Aug 12	1	31000	CWF	3322	29100	19.00		1119	-0.89	560	292	2.4	50	5.75	6.50	2	17.00	142	76		210	147		
	2	30700	CWF	3442	31400	21.00		1123	-0.98	577	297	2.9	50	5.75	6.50	2	17.00	144	74		210	144		
	3	29600	CWF	3298	27500	0.66		1125	-1.06	581	303	2.8	50	5.75	6.50	2	17.00	147	73		210	151		
Aug 13	1	32200	CWF	2679	33700	22.00		1124	-1.04	582	299	3.2	50	5.75	6.50	2	17.00	144	76		210	144		
	2																							
	3																							
Aug 14	1																							
	2																							
	3																							
Aug 15	1																							
	2		HFO																					
	3		HFO																					
Aug 16	1	27600	CWF/HFO	2772	34800	0.82		991	-1.30	567	293	2.5	50	5.00	5.00	2	17.00	130	55		210	176		
	2	30200	CWF	3111	32200	0.61		1019	-0.97	567	293	2.2	50	6.00	6.50	2	17.00	129	67		210	164		
	3	30100	CWF	3255	35400	0.61		978	-0.73	556	288	2.6	50	6.00	6.50	1 / 2	17.00	135	77		210	176		
Aug 17	1	26000	CWF	2482	32100	0.60		953	-0.71	542	290	2.0	50	6.00	6.50	1 / 2	17.00	131	74		210	180	0.0	
	2	19500	CWF	2200	29700	0.58		973	-1.06	530	274	1.6	50	6.00	6.50	1 / 2	17.00	126	67		210	174		
	3	28000	CWF	3195	31600	0.58		1038	-1.25	542	278	2.0	50	6.00	6.50	1 / 2	17.00	149	83		210	130		
Aug 18	1	29900	CWF	3360	31900	0.58		1078	-0.98	564	290	2.4	50	5.75	6.50	2	17.00	145	76		215	122	0.0	
	2	23500	CWF	2559	27100	0.55		1092	-1.13	545	275	2.1	50	5.75	6.50	2	17.00	146	60		213	134	0.0	
	3	24400	CWF	2671	26500	0.57		1064	-0.96	539	271	2.0	50	5.75	6.50	1 / 2	17.00	142	73		211	134		
Aug 19	1	26200	CWF	3015	31500	0.58		1079	-0.98	557	277	2.0	50	5.75	6.50	1 / 2	17.00	147	85		210	129	0.0	
	2	30100	CWF	3285	32300	0.57		1012	-1.09	553	278	2.1	50	5.75	6.50	2	17.00	134	75		210	133		
	3	24500	CWF	2720	27300	0.57		1043	-0.99	546	279	2.0	50	5.75	6.50	1 / 2	17.00	137	67		210	153		
Aug 20	1	28500	CWF	3128	32500	0.57		1019	-0.96	554	285	2.0	50	5.75	6.50	1	17.00	146	86		210	129	0.0	
	2																							
	3																							

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Aug 21	1																							
	2																							
	3																							
Aug 22	1																							
	2	34100	CWF/HFO	3603	37200	0.59		1152	-0.98	571	292	3.0	50	4.00	5.75	1	17.00	154	94		202	179	0.0	
	3	29200	CWF	3009	30900	0.59		1167	-0.91	552	281	2.5	50	4.00	6.00	1	17.00	154	84		210	186		
Aug 23	1	29900	CWF	3306	36300	0.59		1197	-1.07	556	284	2.9	50	4.00	6.00	2	17.00	150	63		209	177	0.0	
	2	27600	CWF	2958	33300	0.59		1090	-0.99	553	283	2.5	50	4.00	6.00	1 / 2	17.00	146	72		208	185	0.0	
	3	27800	CWF	3047	32300	0.57		1063	-1.01	552	282	2.3	50	4.00	6.00	1 / 2	17.00	141	68		210	182		
Aug 24	1	29500	CWF	3154	32500	0.57		1079	-0.89	554	281	2.1	50	4.00	6.00	2	17.00	145	67		210	179		
	2	36300	CWF	4050	35800	0.58		1052	-1.00	575	293	3.4	50	4.00	6.00	2	17.00	147	83		206	175		
	3	23800	CWF	2541	26800	0.58		1042	-1.31	552	276	2.4	50	4.00	6.00	1	17.00	142	71		207	195	0.0	
Aug 25	1	29500	CWF	2980	33100	0.58		1055	-1.00	552	276		50	4.00	6.00	1	17.00	140	76		210	182		
	2	34700	CWF/HFO	2679	29300	0.58		1062	-0.88	549		2.1	50	4.00	6.00	1	17.00	144	71		209	190	0.0	
	3		HFO																					
Aug 26	1		HFO																					
	2		HFO																					
	3		HFO																					
Aug 27	1		HFO																					
	2																							
	3																							
Aug 28	1																							
	2																							
	3																							
Aug 29	1																							
	2	29400	CWF/HFO	2806	23600	0.50		1050	-1.18	555	288	2.8	50	5.75	6.25	1	17.00	150	101		213	116	0.0	
	3	22500	CWF	2560	21800	0.60		1117	-1.10	540	283	2.2	50	5.75	6.25	1	17.00	150	82		210	162	0.0	
Aug 30	1	28400	CWF	3040	28500	0.60		1111	-1.21	551	287	2.0	50	5.75	6.25	1	17.00	150	85		210	183		
	2	28800	CWF	3027	26900	0.49		1024	-1.19	547	280	2.1	50	5.75	6.25	1 / 2	17.00	139	68		209	189		
	3	25300	CWF	2549	16300	0.42		927	-0.93	540	276	2.0	50	5.75	6.25	2	17.00	124	43		208	197	0.0	

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Aug 31	1	26500	CWF	2629	26900	0.59		1087	-1.08	546	280	2.0	50	5.75	6.25	1 / 2	17.00	147	68		210	184		
	2	26900	CWF/NFO	2638	30400	0.60		1077	-0.66	547	279	2.0	50	5.75	6.25	1	17.00	147	69		208	194	0.0	
	3	29100	CWF/NFO	3861	30800	0.57		1054	-0.92	548	278	2.0	50	5.75	6.25	1	17.00	141	74		209	185		

17

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Parameter Date	Parameter Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Aug 01	1																							
	2	39600	HFO	2786	52700	58.50		339	-1.16	444	332	7.6	50	5.50	4.80	1	17.00	65	28		202	122	0.0	0.0
	3	39200	HFO/CWF	2643	47900	1.22		312	-0.92	627	321	8.7	50	4.00	6.00	1	17.00	62	26		210	169	0.0	
Aug 02	1	34100	HFO/CWF	2204	47500	0.97		298	-1.18	607	299	7.0	50	4.00	6.00	1	17.00	59	22		208	183	0.0	
	2	33600	HFO/CWF	2223	44400	32.00		265	-0.89	613	244	6.5	50	4.00	5.50	1	17.00	57	21		203	176	0.0	
	3		CWF																					
Aug 03	1	30300	HFO	2028	35700	23.00		509	-0.86	606	305	4.0	50	4.30	5.40	2	17.00	145	100		209	182	0.0	
	2	35700	HFO/CWF	2545	52300	41.00		507	-0.82	660	374	7.0	50	5.75	3.75	2	17.00	150	110		202	171	0.0	
	3		CWF																					
Aug 04	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 05	1		CWF																					
	2																							
	3																							
Aug 06	1	23000	HFO	1466	31000	0.91		366	-1.14	552	260	2.2	50	5.00	6.50	2	17.00	86	54		210	199	2.5	
	2																							
	3																							
Aug 07	1																							
	2																							
	3																							
Aug 08	1																							
	2	26700	HFO	1853	35700	0.81		432	-0.86	585	296	5.8	50	5.00	2.30	2	17.00	108	65		210	124	0.0	
	3	31700	HFO/CWF	2061	32600	1.00		332	-1.15	597	311	5.9	50	5.00	4.50	2	17.00	104	58		211	117		
Aug 09	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 10	1		CWF																					
	2		CWF																					
	3		CWF																					

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Aug 11	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 12	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 13	1		CWF																					
	2																							
	3																							
Aug 14	1																							
	2																							
	3																							
Aug 15	1	13300	HFO	911	35800	1.01		361	-1.30	520	224	2.5	50	5.50	3.30	1	17.00	95	55		210	105		
	2	28100	HFO	1988	40200	1.07		352	-1.04	558	285	4.3	50	4.70	4.90	2	17.00	113	69		210	131		
	3																							
Aug 16	1	33700	HFO/CWF	2255	46500	1.11		402	-1.02	597	306	5.0	50	5.00	5.00	2	17.00	126	78		210	163		
	2		CWF																					
	3		CWF																					
Aug 17	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 18	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 19	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 20	1		CWF																					
	2																							
	3																							

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Aug 21	1																							
	2																							
	3																							
Aug 22	1																							
	2	28900	HFO/CWF	2016	43100	1.02		241	-0.96	561	279	4.6	50	5.75	2.25	2	17.00	79	39		211	108	0.0	
	3		CWF																					
Aug 23	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 24	1		CWF																					
	2		CWF																					
	3		CWF																					
Aug 25	1		CWF																					
	2	28100	HFO/CWF	1919	40100	1.13		449	-1.02	563		5.0	50	5.75	2.00	2	17.00	108	66		205	187	0.0	
	3	32800	HFO	2210	45200	1.30		494	-1.03	586	289	6.0	50	5.75	2.00	2	17.00	113	69		210	165		
Aug 26	1	31200	HFO	2087	42700	1.13		458	-1.11	587	287	5.2	50	5.75	2.00	2	17.00	115	62		210	170		
	2	33900	HFO	2287	44900	1.13		503	-1.00	602	298	6.1	50	5.75	2.00	2	17.00	122	76		209	165	0.0	
	3	29100	HFO	1961	41600	1.13		424	-1.01	597	298	5.2	50	5.75	2.00	2	17.00	103	60		210	166		
Aug 27	1	26600	HFO	1800	42500	1.13		376	-1.02	581	285	4.4	50	5.75	2.00	2	17.00	89	49		210	186		
	2																							
	3																							
Aug 28	1																							
	2																							
	3																							
Aug 29	1																							
	2	27400	HFO/CWF	2002	37700	0.86		435	-1.17	573	294	4.0	50	5.75	3	1.00	17.00	132	84		211	119	0.0	
	3		CWF																					
Aug 30	1		CWF																					
	2		CWF																					
	3		CWF																					

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Aug 31	1		CWF																					
	2	27900	HFO/CWF	1860.0	35900	0.86		117	-1.12	551	272	2.8	50	5.75	2.9	2	17.00	61	23		210	190	1.5	
	3	24800	HFO/CWF	1552.0	31000	0.97		168	-0.81	545	270	3.0	50	5.75	2.5	2	17.00	58	22		210	192		

SHIFT OPERATOR LOG - BOILER #7: Operation with Coal-Water Fuel at Minas Basin Pulp and Power

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Sep 01	1	34600	CWF	3680	37300	0.58		1045	-0.96	570	293	2.4	50	5.75	6.25	1	17.00	143	81		205	165		
	2	26200	CWF	2644	31000	0.58		1050	-1.25	547	278	2.0	50	5.75	6.25	1	17.00	145	71		208	187	0	
	3	26300	CWF	2803	27700	0.58		1062	-1.08	545	277	2.0	50	5.75	6.25	1	17.00	143	69		210	186	0	
Sep 02	1	38100	CWF	4241	39400	0.58		1047	-1.00	590	301	2.9	50	5.75	6.25	1	17.00	148	87		205	151	0	
	2	31000	CWF	3340	30100	0.58		1059	-1.12	542	289	2.1	50	5.75	6.25	1	17.00	141	71		210	163		
	.3	30200	CWF	3137	26800	0.58		1061	-1.16	549	294	2.1	50	5.75	6.25	1	17.00	140	71		210	160		
Sep 03	1	37400	CWF	3952	34800	0.58		1052	-1.06	586	299	2.1	50	5.75	6.25	1	17.00	147	82		206	151	0	
	2																							
	3																							
Sep 04	1																							
	2																							
	3																							
Sep 05	1																							
	2																							
	3																							
Sep 06	1																							
	2	28700	CWF/HFO	2748	35600	0.86		855	-0.36	531	265	2.0	50	6.00	6.25	2	17.00	118	57		210	103	0	
	3	25600	CWF	2815	33500	0.65		1049	-1.06	544	278	2.3	50	6.00	6.25	2	17.00	141	61		210	105		
Sep 07	1	26100	CWF	2883	32700	0.56		1058	-0.98	541	275	2.0	50	6.00	6.25	2	17.00	140	60		210	152	0	
	2	26400	CWF	2910	29500	0.56		1057	-1.01	551	277	2.0	50	6.00	6.25	2	17.00	140	58		210	166		
	3	29400	CWF	3181	33000	0.84		1051	-0.95	559	277	2.0	50	6.00	6.25	1	17.00	140	64		210	166		
Sep 08	1	29800	CWF	3302	38100	0.55		1169	-0.95	562	279	2.3	50	5.75	6.00	1	17.00	144	68		209	165	0	
	2	23800	CWF	2643	28200	0.54		1019	-1.09	548	259	1.9	50	5.75	6.00	1	17.00	136	52		210	181		
	3	28100	CWF	2992	29800	0.60		1027	-0.85	560	282	2.0	50	5.75	6.00	1 / 2	17.00	140	67		210	166		
Sep 09	1	35000	CWF	3855	36300	0.57		1028	-0.99	581	287	2.4	50	5.75	6.00	1	17.00	147	79		207	155	0	
	2	24100	CWF/HFO	2606	28300	0.52		1042	-1.04	561	279	2.0	50	5.75	6.00	1	17.00	140	69		210	172		
	3		HFO																					
Sep 10	1		HFO																					
	2		HFO																					
	3		CWF/HFO																					

Parameter Date	 Shift	Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Sep 11	1	25600	CWF	2723	31100	0.52		1120	-0.98	561	276	2.3	50	5.75	6.25	2	17.00	149	63		207	169	0	
	2	28000	CWF	3149	32300	0.53		1084	-0.78	558	278	2.1	50	5.75	6.25	2	17.00	149	73		205	167	0.25	
	3	35400	CWF	3911	34400	0.53		1137	-0.96	580	290	2.5	50	5.75	6.25	2	17.00	150	74		210	146	0	
Sep 12	1	28100	CWF	3072	35200	0.53		1153	-1.07	562	274	2.0	50	5.75	6.25	2	17.00	150	67		210	168	0	
	2	32000	CWF	3468	35800	0.50		1016	-1.01	572	286	2.2	50	5.75	6.25	1 / 2	17.00	139	77		205	151	0	
	3	33000	CWF	3760	34600	0.50		1066	-1.12	575	283	2.3	50	5.75	6.25	2	17.00	147	78		205	164	0	
Sep 13	1	25500	CWF	2712	31200	0.52		1075	-0.96	558	271	2.0	50	5.75	6.25	1	17.00	147	66		210	161		
	2	30700	CWF	3232	33100	0.53		1047	-1.02	561	275	2.0	50	5.75	6.25	1	17.00	150	68		205	174	0	
	3	29100	CWF	3175	32300	0.53		1051	-0.94	560	275	1.9	50	5.75	6.25	1	17.00	148	73		209	165	0	
Sep 14	1	30000	CWF	3280	33700	0.53		1050	-1.06	565	280	2.0	50	5.75	6.25	1	17.00	145	73		210	155		
	2	27300	CWF	2898	31500	0.53		1055	-1.05	555	273	1.5	50	5.75	6.25	1	17.00	150	55		205	168	0	
	3	30100	CWF/NFO	3337	36900	0.50		1053	-1.23	551	279	2.0	50	5.75	6.25	2	17.00	145	65		210	152		
Sep 15	1	28100	CWF/NFO	3325	34600	0.50		1052	-1.32	548	280	2.0	50	5.75	6.25	2	17.00	147	78		210	140	0	
	2	[illegible]	CWF/NFO	3112	42000	0.71		1063	-0.68	554	278	3.0	50	5.75	6.25	2	17.00	149	72		210	158	0	
	3	24800	CWF	2874	30000	0.55		1068	-0.89	535	272	2.0	50	5.75	6.25	2	17.00	145	70		210	154	0	
Sep 16	1	28200	CWF	2988	29500	0.59		1067	-1.23	546	275	2.0	50	5.75	6.25	2	17.00	145	72		210	148	0	
	2	30100	CWF	3322	34300	0.54		1063	-1.00	552	278	2.1	50	5.75	6.25	2	17.00	145	72		210	143	0	
	3	33400	CWF	3729	35900	0.53		1060	-0.92	561	286	2.4	50	5.75	6.25	2	17.00	148	79		211	141	0	
Sep 17	1	31600	CWF	3497	33400	0.53		1065	-0.88	557	280	2.1	50	5.75	6.25	2	17.00	147	74		210	151	0	
	2	25200	CWF	2779	33600	0.53		1076	-1.07	545	272	1.8	50	5.75	6.25	2	17.00	150	71		205	180	1	
	3	24300	CWF	2633	32400	0.55		1074	-1.02	562	268	2.0	50	5.75	6.25	1 / 2	17.00	146	64		209	178	0	
Sep 18	1	27000	CWF	2947	32500	0.56		1068	-1.03	549	272	1.9	50	5.75	6.25	1	17.00	148	66		207	171	0	
	2	26700	CWF	2682	28200	0.56		1071	-0.98	554	271	2.0	50	5.75	6.25	1	17.00	148	64		208	175	0	
	3	21900	CWF	2365	28300	0.56		1071	-0.86	551	266	2.0	50	5.75	6.25	1	17.00	148	61		210	184		
Sep 19	1	25100	CWF	2675	28600	0.56		1066	-1.05	554	269	2.0	50	5.75	6.25	1	17.00	145	65		210	186	0	
	2	31300	CWF	3381	33900	0.56		1060	-1.02	581	289	2.0	50	5.75	6.25	1	17.00	148	73		208	152	0	
	3	33500	CWF	3584	33400	0.56		1061	-0.84	587	291	2.0	50	5.75	6.25	1	17.00	149	76		210	146		
Sep 20	1	31800	CWF	3481	34900	0.56		1059	-1.03	581	287	2.0	50	5.75	6.25	1	17.00	148	70		210	152		
	2	29800	CWF	3167	30400	0.56		1064	-1.08	585	289	2.0	50	5.75	6.25	1	17.00	148	68		209	156	0	
	3	27900	CWF	3100	32500	0.56		1061	-0.98	575	289	1.8	50	5.75	6.25	1	17.00	149	68		210	160		

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Sep 21	1	29500	CWF	3188	33000	0.56		1063	-1.02	578	286	2.0	50	5.75	6.25	1	17.00	148	62		210	158		
	2	16200	CWF	2117	30700	0.56		1066	-0.88	566	280	2.0	50	5.75	6.25	1	17.00	150	52		210	160	0	
	3	32500	CWF/HFO	3333	33700	0.56		1001	-0.98	563	283	2.0	50	5.75	6.25	2	17.00	140	70		210	151		
Sep 22	1	31600	CWF/HFO	3404	33500	0.54		1060	-1.00	594	298	2.0	50	5.75	6.25	2	17.00	144	57		210	151		
	2	28600	CWF	3103	32300	0.56		1062	-0.90	579	293	2.0	50	5.75	6.25	2	17.00	147	59		208	167		
	3	29200	CWF	3110	34600	0.56		1063	-1.08	573	287	2.0	50	5.75	6.25	2	17.00	145	62		210	173		
Sep 23	1	30000	CWF	3101	34400	0.56		1063	-0.92	583	291	2.0	50	5.75	6.25	2	17.00	145	64		210	160		
	2	22300	CWF	2388	28500	0.57		1066	-1.06	570	286	2.0	50	5.75	6.25	1 / 2	17.00	143	61		209	171		
	3	31600	CWF	3531	34500	0.58		1055	-0.96	591	298	2.0	50	5.75	6.25	1	17.00	148	71		210	153		
Sep 24	1	32100	CWF	3421	34900	0.58		1056	-1.09	586	297	2.1	50	5.75	6.25	1	17.00	145	72		210	154		
	2	25400	CWF	2536	30200	0.58		1058	-0.96	569	286	2.0	50	5.75	6.25	1	17.00	147	61		209	177	0	
	3	35400	CWF	3770	32600	0.58		1056	-0.98	597	303	2.0	50	5.75	6.25	1	17.00	146	62		210	148		
Sep 25	1	29000	CWF	3134	35400	0.58		1055	-1.01	578	287	2.0	50	5.75	6.25	1	17.00	143	56		210	162		
	2	28000	CWF	3034	31600	0.54		1059	-1.00	568	287	2.0	50	5.75	6.25	2	17.00	145	67		210	165		
	3	28000	CWF	3012	31500	0.54		1055	-0.88	570	291	2.0	50	5.75	6.25	2	17.00	148	65		205	168		
Sep 26	1	29000	CWF	3075	38000	0.54		1057	-1.00	570	284	2.1	50	5.75	6.25	2	17.00	147	65		209	170		
	2	30000	CWF/HFO	3265	34800	0.57		1057	-0.90	572	288	2.0	50	5.75	6.25	2	17.00	142	67		210	133		
	3	30000	CWF	3423	33000	0.55		1002	-1.00	557	295	2.1	50	6.00	6.00	2	17.00	137	63		205	102		
Sep 27	1	32900	CWF	3536	36800	0.55		1002	-0.97	559	289	2.0	50	6.00	6.00	2	17.00	137	64		210	150		
	2	33000	CWF	3559	36500	0.62		1004	-0.95	573	296	2.0	50	6.00	6.00	2	17.00	141	64		210	155		
	3	32800	CWF	3376	37700	0.68		1005	-0.99	576	298	2.3	50	6.00	6.00	2	17.00	141	62		205	144		
Sep 28	1	32300	CWF	3425	37100	0.68		1005	-1.01	581	295	2.0	50	6.00	6.00	1 / 2	17.00	136	54		210	154		
	2	28000	CWF	3154	32900	0.68		1003	-0.90	561	282	2.0	50	6.00	6.00	1	17.00	142	40		210	165		
	3	32700	CWF/HFO	3811	38800	0.54		1055	-1.01	553	285	2.3	50	6.00	6.50	1	17.00	142	44		210	131		
Sep 29	1	26200	CWF	2972	36100	0.54		1055	-1.02	541	279	2.0	50	5.75	6.50	1	17.00	148	41		212	137	0	
	2	23000	CWF	2535	33900			1054	-0.98	538	272	2.0	50	6.00	6.00	1	17.00	145	41		210	144		
	3	24800	CWF	2735	34200			1054	-0.95	538	275	1.8	50	6.00	6.00	1 / 2	17.00	145	58		210	140		
Sep 30	1	26100	CWF	2908	33200	0.56		1057	-1.10	547	277	2.0	50	5.75	6.25	2	17.00	148	60		211	138	0	
	2	24700	CWF	2705	30500	0.47		1059	-1.04	545	278	1.8	50	6.00	6.00	2	17.00	148	52		210	137		
	3	29700	CWF	3323	34500	0.55		1053	-0.98	556	288	1.9	50	6.00	6.00	2	17.00	148	62		205	132		

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Sep 01	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 02	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 03	1		CWF																					
	2																							
	3																							
Sep 04	1																							
	2																							
	3																							
Sep 05	1																							
	2																							
	3																							
Sep 06	1																							
	2	26100	HFO/CWF	1974	38100	0.83		356	-1.13	533	259	2.6	50	6.00	2.50	1	17.00	90	54		210	107		
	3		CWF																					
Sep 07	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 08	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 09	1		CWF																					
	2	27900	HFO/CWF	1838	37700	0.97		237	-1.24	553	259	2.0	50	5.75	2.50	2	17.00	65	28		210	184		
	3	25900	HFO	1798	38900	1.18		203	-0.99	582	280	4.6	50	5.75	2.50	2	17.00	72	31		210	166		
Sep 10	1	32900	HFO	2256	47800	1.21		290	-0.90	596	292	7.0	50	5.75	2.50	2	17.00	83	40		206	158		
	2	23900	HFO	1612	37100	1.21		127	-1.06	568	269	4.1	50	5.75	2.50	2	17.00	66	24		208	185		
	3	27700	HFO/CWF	1804	42600	1.21		296	-1.06	570	272	4.5	50	5.75	2.50	2	17.00	104	61		203	195		

Parameter Date	 Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Sep 11	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 12	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 13	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 14	1		CWF																					
	2		CWF																					
	3	33800	HFO/CWF	2290	44100	0.88		539	-1.17	609	282	4.5	50	5.75	2.50	1	17.00	140	94		210	133		
Sep 15	1	26500	HFO/CWF	1755	38000	0.85		440	-1.05	544	271	3.0	50	5.75	2.50	1	17.00	148	90		210	143	0	
	2	26800	HFO/CWF	1689	41600	0.83		255	-1.34	548	255	2.8	50	5.75	2.50	1	17.00	91	55		209	158	0	
	3		CWF																					
Sep 16	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 17	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 18	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 19	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 20	1		CWF																					
	2		CWF																					
	3		CWF																					

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Sep 21	1		CWF																					
	2		CWF																					
	3	19800	HFO/CWF	1355	32100	0.87		42	-1.04	552	269	2	50	5.75	2.60	1 / 2	17.00	72	32		203	154		
Sep 22	1	29800	HFO/CWF	1977	39200	0.92		162	-1.25	604	293	4.0	50	5.75	2.50	2	17.00	28	36		210	152		
	2		CWF																					
	3		CWF																					
Sep 23	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 24	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 25	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 26	1		CWF																					
	2	17300	HFO/CWF	1165	38600	1.19		276	-1.28	534	258	2.0	50	6.00	3.75	2	17.00	85	41		210	147		
	3		CWF																					
Sep 27	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 28	1		CWF																					
	2		CWF																					
	3	28200	HFO/CWF	1992	38400	0.90		178	-1.04	564	279	3.5	50	6.00	2.50	1	17.00	60	18		210	106		
Sep 29	1		CWF																					
	2		CWF																					
	3		CWF																					
Sep 30	1		CWF																					
	2		CWF																					
	3		CWF																					

SHIFT OPERATOR LOG - BOILER #7: Operation with Coal-Water Fuel at Hines Basin Pulp and Power

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Oct 01	1	31800	CWF	3463	28800	0.55		1057	-1.01	565	291	2.0	50	5.75	6.25	2	17.00	148	65		211	130	0.00	
	2	20800	CWF/HFO	2102	19300	0.89		991	-0.81	583	299	2.0	50	6.00	6.00	2	17.00	140	58		210	130		
	3	26700	CWF	2686	27600	0.69		1136	-0.90	580	287	2.3	50	6.00	6.00	2	17.00	149	69		205	138		
Oct 02	1	26700	CWF	2944	25600	0.63		1184	-1.04	581	290	2.0	50	5.75	6.25	2	17.00	152	73		211	142	0.00	
	2	25800	CWF/HFO	2928	31200	0.63		1186	-1.16	584	296	2.0	50	6.00	6.00	2	17.00	150	73		205	132	0.00	
	3		HFO																					
Oct 03	1		HFO																					
	2	30600	CWF/HFO	3412	30600	0.53		1013	-0.91	625	286	2.0	50	6.00	6.00	1	17.00	148	79			145	0.00	
	3	30900	CWF	3494	34800	0.53		1045	-0.90	631	287	2.1	50	5.75	6.25	1	17.00	148	68			140	0.00	
Oct 04	1	33800	CWF	3844	38000	0.53		1047	-1.07	642	290	2.0	50	5.75	6.25	1	17.00	145	66			133	0.00	
	2	29000	CWF	3223	33300	0.53		1050	-1.00	646	284	2.1	50	6.00	6.00	1	17.00	148	60		202	136	0.00	
	3	33800	CWF	3827	38100	0.53		1083	-1.00	654	292	2.0	50	5.75	6.25	1	17.00	149	66		203	133	0.00	
Oct 05	1	32000	CWF	3636	30900	0.53		1092	-1.02	658	285	2.0	50	5.75	6.25	1	17.00	150	64		205	131		
	2	27300	CWF	2983	26400	0.53		1082	-1.08	666	279	2.0	50	6.00	6.00	1	17.00	150	56		205	144		
	3	34300	CWF	3841	31100	0.53		1092	-1.01	666	293	2.5	50	5.75	6.25	1	17.00	150	68		205	132		
Oct 06	1	33500	CWF	3680	34000	0.53		1091	-0.97	666	296	2.0	50	6.00	6.00	1	17.00	151	63		210	136		
	2	28700	CWF/HFO	2983	35400	0.53		1090	-1.02	672	287	1.5	50	6.00	6.00	1	17.00	150	62		205	158	0.00	
	3	31500	CWF/HFO	3520	38600	0.54		1073	-0.92	683	286	2.0	50	6.00	6.00	1	17.00	150	59		205	132	0.00	
Oct 07	1	32100	CWF	3449	36200	0.54		1072	-0.97	687	287	2.0	50	6.00	6.00	1	17.00	148	60		210	146		
	2	33200	CWF	3648	36800	0.54		1072	-0.88	690	288	2.1	50	6.00	6.00	1	17.00	150	57		210	156		
	3	30400	CWF	3208	34000	0.54		1070	-1.02	699	284	2.0	50	5.75	6.25	1	17.00	149	53		203	161		
Oct 08	1	28700	CWF	3046	39600	0.54		1060	-1.00	699	283	2.0	50	6.00	6.00	1	17.00	149	53		210	158		
	2	27600	CWF	2918	40200	0.54		1062	-0.97	708	280	2.0	50	6.00	6.00	1	17.00	150	56		205	153		
	3																							
Oct 09	1																							
	2																							
	3																							
Oct 10	1																							
	2																							
	3																							

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)		(%)	(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Oct 11	1																							
	2																							
	3																							
Oct 12	1																							
	2																							
	3																							
Oct 13	1																							
	2																							
	3																							
Oct 14	1																							
	2																							
	3																							
Oct 15	1																							
	2																							
	3																							
Oct 16	1																							
	2																							
	3																							
Oct 17	1																							
	2																							
	3																							
Oct 18	1																							
	2																							
	3		HFO																					
Oct 19	1																							
	2		HFO																					
	3		HFO																					
Oct 20	1																							
	2	31500	CWF/HFO	3328	48000	0.84		933	-0.51	662	278	5.6	50	3.00	6.50	1	17.00	135	93		210	181	2.50	
	3	36800	CWF	3497	48400	0.82		1034	-1.01		295	4.9	50	3.50	6.50	1 / 2	17.00	147	85		210	212	2.00	

Parameter Date	 Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Oct 21	1	42500	CWF	4550	53100	0.82		1022	-0.96		300	5.8	50	3.40	6.25	2	17.00	148	90		211	216	1.10	
	2	39900	CWF	4257	50700	0.81		1023	-0.99		296	5.2	50	3.75	6.25	1 / 2	17.00	150	93		210	212	3.00	
	3	35500	CWF	3769	47500	0.80		1030	-0.88		290	4.1	50	3.75	6.25	1	17.00	148	71		224	219	5.10	
Oct 22	1	35400	CWF	3770	45600	0.80		1030	-0.96		288	4.3	50	3.75	6.25	1	17.00	149	75		210	217	3.60	
	2		HFO																					
	3		HFO																					
Oct 23	1		HFO																					
	2	27700	CWF/HFO	3043	32800	0.53		1039	-1.04		276	2.4	50	5.75	6.00	1	17.00	145	49		214	220	6.00	
	3	29900	CWF	3142	33400	0.53		1038	-1.06		274	2.3	50	5.75	6.00	1	17.00	148	50		216	224	7.10	
Oct 24	1	35000	CWF/HFO	3381	33300	0.63		840	-0.84		267	3.0	50	6.00	2.00	2	16.00	130	78		220	220	8.50	
	2	37000	CWF/HFO	2884	34600	0.55		1035	-1.18		281	2.7	50	6.00	6.00	1 / 2	16.00	143	73		210	217	5.70	
	3		HFO																					
Oct 25	1		HFO																					
	2	33600	CWF/HFO	3737	26000	0.54		1025	-1.32		284	3.5	50	4.75	6.00	1	16.00	155	80		210	225	8.00	
	3	34400	CWF	3622	35400	0.54		1012	-1.09		289	1.9	50	5.00	6.00	1	17.00	150	88		208	212	3.50	
Oct 26	1	33200	CWF	3512	35100	0.54		1024	-0.98		282	2.0	50	5.00	6.00	1	17.00	150	86		209	217	5.10	
	2	34300	CWF	3266	34600	0.56		1056	-0.57		280	2.0	50	4.75	6.00	1	16.00	150	80		210	220	0.00	
	3	38800	CWF/HFO	4204	39400	0.54		992	-1.08		293	3.0	50	3.00	6.00	1	17.00	146	85		210	215	4.80	
Oct 27	1	40800	CWF	4494	32600	0.54		1025	-0.98		287	2.4	50	6.00	2.75	1 / 2	16.00	150	92		202	213	1.50	
	2	40200	CWF/HFO	4156	32600	0.54		1036	-0.96		285	3.0	50	6.50	3.25	2	16.00	145	82		210	222	5.00	
	3	34400	CWF/HFO	3535	35600	0.62		1010	-0.93		285	3.4	50	3.00	6.00	1 / 2	17.00	145	80		210	219	5.20	
Oct 28	1	34900	CWF	3748	26500	0.54		958	-0.98		277	2.0	50	3.00	6.00	1 / 2	16.00	146	86		206	220	4.40	
	2		HFO																					
	3		HFO																					
Oct 29	1		HFO																					
	2		HFO																					
	3	31800	CWF/HFO	3498	57900	0.84		1094	-1.10		270	4.0	50.0	5.75	6.00	2	16.00	146			220	218	7.00	
Oct 30	1	31900	CWF	3396	30400	0.40		1099	-1.00		269	1.2	50.0	5.75	6.00	2	16.00	149	74		207	220	8.30	
	2	29300	CWF	3118	29700	0.52		1118	-0.65		273	1.9	50.0	4.50	6.00	2	16.00	150	67		216	218	6.20	
	3	31800	CWF	3344	30500	0.53		1126	-0.90		276	1.9	50.0	4.50	6.00	2	16.00	150	69		206	215	6.40	

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Oct 31	1	31700	CWF/NFO	3306	30200	0.53		1126	-0.90		269	2.0	50.0	4.50	6.00	2	16.00	149	68		210	227	7.40	
	2	29100	CWF/NFO	3126	32200	0.59		1059	-1.01		264	2.2	50.0	5.75	3.00	1	16.00	148	77		215	222	5.80	
	3	29500	CWF	3070	32000	0.59		1083	-0.72		275	2.1	50.0	5.75	3.00	1	16.00	150	79		210	221	6.50	

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Date	Shift	Steam Flow (lb/hr)	Fuel Type (HFO/CWF)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Oct 01	1		CWF																					
	2	31200	HFO/CWF	2265	45800	1.17		465	-1.04	602	302	5.6	50	6.00	3.75	2	17.00	145	85		210	124		
	3		CWF																					
Oct 02	1		CWF																					
	2	33600	HFO/CWF	2396	39500	0.97		491	-1.02	625	314	5.3	50	6.00	2.50	2	17.00	150	104		205	129	0.00	
	3	32000	HFO	2232	38400	1.00		236	-1.01	618	303	5.2	50	5.75	2.50	2	17.00	117	69		212	127	0.00	
Oct 03	1	33200	HFO	2307	41600	1.00		251	-1.00	636	299	5.9	50	5.75	2.50	2	17.00	119	72		210	131	0.00	
	2	34400	HFO/CWF	2346	42200	1.00		247	-0.97	650	306	5.5	50	6.00	2.50	2	17.00	117	72			134	0.00	
	3		CWF																					
Oct 04	1		CWF																					
	2		CWF																					
	3		CWF																					
Oct 05	1		CWF																					
	2		CWF																					
	3		CWF																					
Oct 06	1		CWF																					
	2	34100	HFO/CWF	2505	44700	0.92		365	-0.53	648	250	5.5	50	6.00	2.25	1	17.00	98	46		205	129	0.00	
	3	34700	HFO/CWF	2420	52300	1.13		335	-1.04	655	309	6.0	50	6.00	2.25	1	17.00	85	39		206	113	0.00	
Oct 07	1		CWF																					
	2		CWF																					
	3		CWF																					
Oct 08	1		CWF																					
	2		CWF																					
	3																							
Oct 09	1																							
	2																							
	3																							
Oct 10	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Oct 11	1																							
	2																							
	3																							
Oct 12	1																							
	2																							
	3																							
Oct 13	1																							
	2																							
	3																							
Oct 14	1																							
	2																							
	3																							
Oct 15	1																							
	2																							
	3																							
Oct 16	1																							
	2																							
	3																							
Oct 17	1																							
	2																							
	3																							
Oct 18	1																							
	2																							
	3	28800	HFO	2164	37500	0.97		431	-1.25		293	7.0	60	6.00	3.00	2	17.00	125	72		205	98	0.00	
Oct 19	1																							
	2	35800	HFO	2539	47100	0.92		451	-1.10	737	315	7.0	65	5.75	3.00	2	17.00	133	85		210	145	0.00	
	3	31600	HFO	1940	46000	0.78		294	-1.20	719	290	4.3	65	5.75	3.60	2	17.00	127	80		210	217	4.30	
Oct 20	1																							
	2	39400	HFO/CWF	2898	56600	1.13		227	-0.89	730	290	4.9	50	6.00	2.00	2	17.00	141	98		210	130	0.00	
	3		CWF																					

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Oct 21	1		CWF																					
	2		CWF																					
	3		CWF																					
Oct 22	1		CWF																					
	2	35600	HFO	2285	45800	0.91		100	-1.17		282	3.4	50	6.50	3.00	1	16.00	59	24		210	209	1.30	
	3	35200	HFO	1994	39000	0.91			-0.87		270	2.8	50	6.50	3.00	1	16.00	57	19		210	216	6.40	
Oct 23	1	32100	HFO	2017	36000	0.91			-1.02		267	2.5	50	5.75	3.00	1	17.00	53	19		217	222	6.40	
	2	21900	HFO/CWF	1373	31400	0.91			-1.20		351	2.0	50	5.75	3.00	1	17.00	45	22		220	220	6.00	
	3		CWF																					
Oct 24	1	37100	HFO/CWF	2360	47700	0.93		101	-1.10		266	3.2	50	6.00	2.00	2	16.00	75	38		220	210	2.50	
	2	31600	HFO/CWF	2096	55900	0.92		205	-0.91		286	5.0	50	6.00	0.00	2	16.00	60	44		210	220	5.00	
	3	36600	HFO	2264	50400	1.16		144	-0.97		280	4.5	50	5.75	3.00	2	17.00	98	52		217	223	6.30	
Oct 25	1	32400	HFO	2098	47400	1.16		106	-1.02		292	4.5	50	5.75	3.00	2	17.00	92	48		210	220	6.60	
	2	31800	HFO/CWF	2082	47100	1.22		126	-0.94	545	288	4.5	50	5.75	2.81	2	16.00	89	44		210	220	5.00	
	3		CWF																					
Oct 26	1		CWF																					
	2		CWF																					
	3	35200	HFO/CWF	2366	52200	1.02		309	-1.18		288	4.0	50	6.00	2.75	1	17.00	120	73		210	157	0.00	
Oct 27	1		CWF																					
	2	30200	HFO/CWF	1883	53400	0.94			-1.04		276	5.4	50	6.00	3.00	2	16.00	98	50		210	220	6.80	
	3	22500	HFO/CWF	1445	58700	0.94			-0.83		273	6.0	50	6.00	3.00	1 / 2	17.00	85	44		210	222	7.50	
Oct 28	1		CWF																					
	2	19500	HFO	1444	49200	0.78			-1.06		259	4.3	50	6.00	3.00	1	16.00	74	37		210	227	7.30	
	3	14900	HFO	1136	50900	0.79			-1.03		262	4.9	50	5.75	3.00	1	17.00	66	32		219	226	7.80	
Oct 29	1	30500	HFO	1970	46200	0.79		187	-1.10		252	4.4	50	5.75	3.00	1	16.00	91	54		206	216	5.50	
	2	18600	HFO	1266	48100	0.94			-0.99		267	3.4	50	5.75	3.00	2	16.00	73	34		210	228	7.20	
	3	21700	HFO/CWF	1426	38500	0.98			-1.09		276	3.6	50	5.75	3.00	2	16.00	72	38		219	221	7.30	2.0
Oct 30	1		CWF																					
	2		CWF																					
	3		CWF																					

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Oct 31	1	9900	HFO/CWF	1161	41600	0.48			-1.03		257	4.0	50	5.75	3.00	2	16.00	60	10		210	230	10.00	2.0
	2	22700	HFO/CWF	1452	35900	0.90			-0.88		250	2.4	50	5.75	3.00	2	16.00	55	21		217	224	7.80	2.0
	3		CWF																					

3

SHIFT OPERATOR LOG - BOILER #7: Operation with Coal-Water Fuel at Minas Basin Pulp and Power

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Tert. Damp. (O/C)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Nov 01	1	39400	CWF/HFO	4306	39000	0.59		1088	-1.37		278	3.3	50	5.75	3.00		1	16.00	150	93		206	207	2.30	
	2	28500	CWF/HFO	3051	34000	0.55		1082	-0.95		285	2.3	50	4.50	5.75		2	16.00	148	67		214	220	5.90	
	3		HFO																						
Nov 02	1		HFO																						
	2		HFO																						
	3		HFO																						
Nov 03	1		HFO																						
	2		HFO																						
	3		HFO																						
Nov 04	1	38600	CWF/HFO	3670	37300	0.55		966	-1.37		308	2.0	50	5.75	6.50		2	16.00	155	100		210	206	0.00	
	2	35400	CWF/HFO	3671	28700	0.57		981	-1.68		301	2.3	50	5.75	6.50		2	16.00	150	99		210	207	4.00	
	3		HFO																						
Nov 05	1		HFO																						
	2		HFO																						
	3		HFO																						
Nov 06	1		HFO																						
	2		HFO																						
	3		HFO																						
Nov 07	1		HFO																						
	2		HFO																						
	3		HFO																						
Nov 08	1		HFO																						
	2		HFO																						
	3		HFO																						
Nov 09	1		HFO																						
	2		HFO																						
	3	36000	CWF/HFO	4005	44900	0.79		1084	-0.99		302	7.5	50	3.00	6.00	0	2	16.00	153	82		210	223	7.10	
Nov 10	1	37000	CWF	4026	46300	0.79		1095	-1.01		301	8.0	50	3.00	6.00	0	2	16.00	150	72		210	216	4.50	
	2	36100	CWF/HFO	3830	34300	0.49		1104	-0.91		289	4.1	50	3.00	6.00	0	2	16.00	150	65		205	215	4.00	
	3		HFO																						

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Tert. Damp. (O/C)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Nov 11	1		NFO																						
	2		NFO																						
	3		NFO																						
Nov 12	1		NFO																						
	2		NFO																						
	3		NFO																						
Nov 13	1		NFO																						
	2		NFO																						
	3		NFO																						
Nov 14	1		NFO																						
	2	28800	CWF/NFO	3317	42100	0.64		1013	-0.71		311	4.1	50	3.00	6	C	1	16.00	150	70		205	220	6.00	
	3	39200	CWF	4077	42900	0.64		1046	-1.01		296	3.6	50	3.00	6	O	1	16.00	153	108		208	209	3.10	
Nov 15	1	38500	CWF/NFO	4066	38900	0.64		1087	-0.98		299	3.2	50	3.00	6	O	1	16.00	151	89		207	211	2.00	
	2		NFO																						
	3		NFO																						
Nov 16	1		NFO																						
	2		NFO																						
	3		NFO																						
Nov 17	1		NFO																						
	2		NFO																						
	3		NFO																						
Nov 18	1		NFO																						
	2		NFO																						
	3																								
Nov 19	1																								
	2																								
	3																								
Nov 20	1																								
	2																								
	3																								

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Tert. Damp. (O/C)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Nov 21	1																								
	2																								
	3																								
Nov 22	1																								
	2																								
	3																								
Nov 23	1																								
	2																								
	3																								
Nov 24	1																								
	2	29	HFO/CWF	2972	31	0.55		999	-1.84		282	1.5	50	3.00	6.50	C/O	1	16.00	142	73		222	219	8	
	3																								
Nov 25	1																								
	2																								
	3																								
Nov 26	1																								
	2																								
	3																								
Nov 27	1																								
	2																								
	3																								
Nov 28	1																								
	2																								
	3																								
Nov 29	1																								
	2																								
	3																								
Nov 30	1																								
	2																								
	3																								

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Tert. Damp. (O/C)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)																	
Nov 01	1	39500	HFO/CWF	2515	44100	0.81		306	-1.21		286	3.4	50	6.00	4.00		2	16.00	150	67		204	212	5.80	
	2	20800	HFO/CWF	1427	33400	0.89		108	-1.40		278	2.0	50	5.75	4.00		2	16.00	74	19		213	218	4.50	
	3	34900	HFO	2336	44400	0.96		235	-0.92		307	4.4	50	5.75	3.60		2	16.00	117	49		208	210	2.60	
Nov 02	1	34500	HFO	2334	39100	0.88		226	-0.93		334	4.6	50	5.75	4.50		2	16.00	131	56		202	209	0.40	
	2	26000	HFO	1758	33300	1.00		143	-0.50		322	3.5	50	5.75	3.50		2	16.00	97	27		207	211	2.50	
	3	30300	HFO	2543	50000	1.11		339	-0.92		316	3.9	50	5.75	2.00		1	16.00	128	54		202	207	1.10	
Nov 03	1	38800	HFO	2576	47600	1.11		240	-0.97		320	5.1	50	5.75	2.00		1	16.00	118	54		210	206	2.60	
	2	35500	HFO	2364	46100	1.11		196	-1.02		307	5.3	50	5.75	2.00		1	16.00	114	44		207	206	1.50	
	3	37400	HFO	2385	46400	1.11		199	-1.01		310	5.9	50	5.75	2.00		1	16.00	116	43		205	215	3.30	
Nov 04	1	35400	HFO/CWF	2343	42300	0.97		189	-0.98		303	5.1	50	5.75	2.90		2	16.00	161	85		210	215	3.60	
	2	43400	HFO/CWF	2811	53700	0.97		335	-1.03		313	6.0	50	5.75	2.00		2	16.00	160	85		208	210	3.00	
	3	31500	HFO	2133	56700	1.24		341	-0.88		304	4.6	50	6.00	3.30		1	16.00	146	70		210	214	4.40	
Nov 05	1	40900	HFO	2703	59000	1.28		305	-0.99		324	6.1	50	6.00	3.50		1	16.00	155	83		208	207	1.80	
	2	28400	HFO	1834	47800	1.28		222	-1.06		286	3.5	50	5.75	3.50		1	16.00	123	50		214	217	5.16	
	3	32500	HFO	2119	50800	1.28		309	-1.03		304	3.9	50	5.75	3.50		1	16.00	131	63		204	218	5.00	
Nov 06	1	29300	HFO	1921	45800	1.28		247	-1.10		294	4.6	50	5.75	3.50		1	16.00	125	56		210	228	8.40	
	2	29400	HFO	2020	46500	1.28		258	-1.13		287	3.3	50	5.75	3.50		1	16.00	121	50		205	227	7.40	
	3	28300	HFO	1930	48500	1.28		274	-0.92		293	3.9	50	5.75	3.50		1	16.00	127	50		208	214	4.40	
Nov 07	1	28800	HFO	1958	49200	1.28		282	-0.89		289	4.6	50	5.75	3.50		1	16.00	130	55		213	216	5.30	
	2	33500	HFO	2262	46900	1.15		322	-0.91		309	4.3	50	5.75	3.50		1 / 2	16.00	132	61		207	197	4.30	
	3	47000	HFO	3117	62100	1.11		254	-1.07		338	6.3	50	6.00	2.00	O	1	16.00	165	101		200	201	0.83	
Nov 08	1	42900	HFO	2821	62200	1.11		249	-0.99		325	5.1	50	6.00	2.00	O	1	16.00	155	93		210	205	3.70	
	2	28100	HFO	1809	50800	1.11			-1.08		280	3.0	50	6.00	2.00	O	1	16.00	100	36		208	218	5.00	
	3	36800	HFO	2422	57000	1.07		155	-1.21		308	4.6	50	6.00	2.00	O	1	16.00	152	88		200	205	4.40	
Nov 09	1	39200	HFO	2647	5700	1.11		209	-0.92		318	6.0	50	6.00	2.00	O	1	16.00	158	93		200	200	3.10	
	2	38000	HFO	2460	51300	1.11			-0.92		308	4.7	50	6.00	2.00	O	1	16.00	158	89		206	207	3.00	
	3	26400	HFO/CWF	1707	41000	1.11			-1.02		272	4.0	50	6.00	2.00	O	1	16.00	126	56		210	222	7.00	
Nov 10	1		CWF																						
	2	37400	HFO/CWF	2446	58400	1.00		169	-1.02		291	7.0	50	6.00	2.00	C	2	16.00	150	90		205	216	4.00	
	3	34100	HFO	2238	49500	1.20		62	-0.97		297	5.1	50	6.00	3.00	O	2	16.00	159	87		210	220	7.40	

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Tert. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	(O/C)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Nov 11	1		HFO																						
	2		HFO																						
	3		HFO																						
Nov 12	1	35000	HFO	2297	45900	1.14		79	-1.01		294	6.0	50	5.75	3.25	O	2	16.00	153	90		214	219	6.60	
	2	32600	HFO	2174	48200	1.00			-0.99		290	3.6	50	5.75	3.25	O	1	16.00	56	20		209	190	3.00	
	3	38100	HFO	2459	49700	1.00			-1.09		312	4.3	50	5.75	2.00	O	1	16.00	93	83		205	203	1.40	
Nov 13	1	38300	HFO	2501	50100	1.00			-1.03		301	4.4	50	5.75	2.25	O	2	16.00	133	65		211	215	2.90	
	2	34900	HFO	2270	47300	1.00			-0.88		291	4.0	50	5.75	2.25	O	2	16.00	134	63		205	212	7.70	
	3	35500	HFO	2341	47600	1.00			-1.05		294	4.3	50	5.75	2.25	O	2	16.00	119	51		212	214	1.70	
Nov 14	1	33600	HFO	2207	44200	1.00			-0.96		281	3.6	50	5.75	2.25	O	1	16.00	67	13		209	219	6.80	
	2	35100	HFO/CWF	2363	50800	1.00			-1.18		311	4.1	50	5.75	2.25	O	1	16.00	85	23		205	210	6.30	
	3		CWF																						
Nov 15	1	42900	HFO/CWF	2909	52700	0.96			-0.96		291	4.8	50	5.75	2.00	O	1	16.00	100	31		210	214	2.50	
	2	33200	HFO	2147	40500	0.94			-1.04		281	4.6	50	5.75	2.00	O / C	1	16.00	71	19		205	219	3.30	
	3	32500	HFO	2148	38800	0.94			-1.04		287	4.3	50	5.75	2.00	C	1	16.00	64	23		205	209	4.10	
Nov 16	1	37800	HFO	2452	43400	0.94			-0.99		285	5.1	50	5.75	2.00	C	1	16.00	92	26		208	208	1.40	
	2	24400	HFO	1577	36300	0.94			-0.80		267	3.5	50	5.75	2.00	C	1	16.00	55	20		205	218	3.00	
	3	39500	HFO	2603	45000	0.92			-1.80		286	4.5	50	5.75	2.00	C	1	16.00	89	24		209	199	2.00	
Nov 17	1	42100	HFO	2770	50300	0.94			-1.83		295	5.1	50	5.50	2.00	C	1	16.00	143	89		211	203	1.40	
	2	38300	HFO	2496	44600	0.96		141	-1.72		292	4.6	50	5.75	2.00	C	1	16.00	154	93		212	205	3.10	
	3	35100	HFO	2330	39900	0.96			-1.85		287	4.0	50	5.75	2.00	C	1	16.00	167	95		209	214	3.50	
Nov 18	1	42100	HFO	2633	47500	0.96		142	-1.91		302	4.1	50	5.75	2.00	C	1	16.00	171	99		209	196	2.40	
	2	36000	HFO	2231	41300	0.96		117	-1.88		285	3.7	50	5.75	2.00	C	1	16.00	153	81		212	209	7.70	
	3																								
Nov 19	1																								
	2																								
	3																								
Nov 20	1																								
	2																								
	3																								

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Tert. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/WFO)	(lb/hr)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	(O/C)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Nov 21	1																								
	2																								
	3																								
Nov 22	1																								
	2																								
	3																								
Nov 23	1																								
	2																								
	3																								
Nov 24	1																								
	2	25	WFO/CWF	1782	49	0.70		118	-1.78		243	3.0	50	5.75	2.00	C	2	16.00	128	58		220	219	7	
	3																								
Nov 25	1																								
	2																								
	3																								
Nov 26	1																								
	2																								
	3																								
Nov 27	1																								
	2																								
	3																								
Nov 28	1																								
	2																								
	3																								
Nov 29	1																								
	2																								
	3																								
Nov 30	1																								
	2																								
	3																								

SHIFT OPERATOR LOG - BOILER #7: Operation with Coal-Water Fuel at Minas Basin Pulp and Power

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Feb 01	1		CWF																					
	2																							
	3																							
Feb 02	1																							
	2																							
	3																							
Feb 03	1																							
	2																							
	3																							
Feb 04	1																							
	2																							
	3																							
Feb 05	1																							
	2																							
	3																							
Feb 06	1																							
	2																							
	3																							
Feb 07	1																							
	2																							
	3																							
Feb 08	1																							
	2																							
	3																							
Feb 09	1																							
	2																							
	3																							
Feb 10	1																							
	2																							
	3																							

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(lb/hr)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Feb 11	1																							
	2																							
	3																							
Feb 12	1																							
	2																							
	3																							
Feb 13	1																							
	2																							
	3																							
Feb 14	1																							
	2																							
	3																							
Feb 15	1																							
	2																							
	3																							
Feb 16	1																							
	2																							
	3																							
Feb 17	1																							
	2																							
	3																							
Feb 18	1																							
	2																							
	3																							
Feb 19	1																							
	2																							
	3																							
Feb 20	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/RFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Feb 21	1																							
	2																							
	3																							
Feb 22	1																							
	2																							
	3																							
Feb 23	1																							
	2																							
	3																							
Feb 24	1																							
	2																							
	3																							
Feb 25	1																							
	2																							
	3																							
Feb 26	1																							
	2																							
	3																							
Feb 27	1																							
	2																							
	3																							
Feb 28	1																							
	2																							
	3																							

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATN Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATN Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Feb 01	1		HFO																					
	2																							
	3																							
Feb 02	1																							
	2																							
	3																							
Feb 03	1																							
	2																							
	3																							
Feb 04	1																							
	2																							
	3																							
Feb 05	1																							
	2																							
	3																							
Feb 06	1																							
	2																							
	3																							
Feb 07	1																							
	2																							
	3																							
Feb 08	1																							
	2																							
	3																							
Feb 09	1																							
	2																							
	3																							
Feb 10	1																							
	2																							
	3																							

Parameter Date	 Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (%)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Feb 11	1																							
	2																							
	3																							
Feb 12	1																							
	2																							
	3																							
Feb 13	1																							
	2																							
	3																							
Feb 14	1																							
	2																							
	3																							
Feb 15	1																							
	2																							
	3																							
Feb 16	1																							
	2																							
	3																							
Feb 17	1																							
	2																							
	3																							
Feb 18	1																							
	2																							
	3																							
Feb 19	1																							
	2																							
	3																							
Feb 20	1	26.8	HFO	29.4	32090			247	-1.94	538	368	5.0	60	6.00	2.00	1	16.75	79	33				6	
	2	32.5	HFO	29.5	37390			283	-2.01	555	379		60	6.00	2.00	1	16.75	89	45				6	
	3	33.0	HFO	35.9	38380			309	-2.01	582	387	3.0	60	6.00	2.00	1	16.75	92	45		200	220	5	

Parameter Date	 Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (%)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Feb 21	1	28.7	HFO	29.0	33000			154	-1.91	539	363	2.0	60	6.00	2.00	2	16.75	81	35		190	220	5	
	2	27.6	HFO	29.0	32000			82	-2.00	548	369	2.0	60	6.00	2.00	2	16.75	78	34		190	220	6	
	3	28.1	HFO	30.0	32590			82	-2.03	550	369	3.0	60	6.00	2.00	2	16.75	79	35		190	220	5	
Feb 22	1	25.5	HFO	27.6	28800			55	-1.88	519	339	2.0	60	6.00	2.00	2	16.75	104	30		190	220	6	
	2	32.3	HFO	34.5	36960			98	-1.98	564	378	3.0	60	6.00	2.00	2	16.75	89	44		190	220	5	
	3	37.1	HFO	41.0	44000			175	-1.98	612	401	4.0	60	6.00	2.00	2	16.75	101	57		190	215	1	
Feb 23	1	36.7	HFO	39.3	39800			167	-1.96	581	378	4.0	60	6.00	2.00	2	16.75	128	50		190	215	2	
	2																							
	3																							
Feb 24	1	22.3	HFO	24.6	28750			381	-1.99	478	325	1.0	60	6.00	2.00	1	16.75	72	22		190	230	8	
	2	28.6	HFO	31.1	33040			329	-1.86	517	346	2.0	60	6.00	2.00	2	16.75	81	34		190	220	6	
	3	28.7	HFO	31.6	34780			294	-2.02	522	346	2.0	60	6.00	2.00	2	16.75	82	36		187	225	7	
Feb 25	1	27.8	HFO	30.7	34060			267	-1.95	521	344	2.0	60	6.00	2.00	2	16.75	80	29		190	225	7	
	2	30.9	HFO	33.3	36410			308	-1.92	542	346	2.0	60	6.00	2.00	2	16.75	86	39		190	230	8	
	3	34.9	HFO	37.4	40830			333	-2.09	570	370	3.0	60	5.75	2.00	2	16.75	94						
Feb 26	1	27.5	HFO	30.2	33430			269	-1.94	522	353	2.0	60	5.75	2.00	2	16.75	80	37		190	230	7	
	2	29.3	HFO	32.2	36030			283	-1.91	529	354	2.0	60	5.75	2.00	2	16.75	84	38		192	222	8	
	3	33.6	HFO	37.0	40000			330	-2.01	560	366	3.0	60	5.75	2.00	2	16.75	94	48		190	220	6	
Feb 27	1	24.8	HFO	27.1	30940			265	-1.97	466	334	2.0	60	5.75	2.00	2	16.75	79	32		190	230	7	
	2	28.8	HFO	31.7	34770			137	-2.02	538	359	2.0	60	5.75	2.00	2	16.75	83	38		190	228	7	
	3	32.3	HFO	35.1	38190			148	-2.01	557	369	2.0	60	5.75	2.00	2	16.75	90	45		190	230	7	
Feb 28	1	30.0	HFO	33.3	36510			140	-2.02	563	372	2.0	60	5.75	2.00	2	16.75	87	41		190	230	7	
	2	30.9	HFO	34.1	37410			117	-2.02	560	370	2.0	60	5.75	2.00	2	16.75	88	43		190	220	7	
	3	31.5	HFO	34.7	37900			134	-2.06	568	365	2.0	60	5.75	2.00	2	16.75	89	46		185	230	7	

SHIFT OPERATOR LOG - BOILER 07: Operation with Coal-Water Fuel at Mines Basin Pulp and Power

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (%)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Mar 01	1																							
	2																							
	3																							
Mar 02	1																							
	2																							
	3																							
Mar 03	1																							
	2																							
	3																							
Mar 04	1																							
	2																							
	3																							
Mar 05	1																							
	2																							
	3																							
Mar 06	1																							
	2																							
	3																							
Mar 07	1																							
	2																							
	3																							
Mar 08	1	28630	CWF	24.20	28260			658	-2.00	532	339	1.0	60	3.00	6.50	2	16.75	87	70		187	225	8	
	2	35540	CWF	30.57	30170			843	-2.00	570	396	2.0	60	3.00	6.50	2	16.75	94	84		180	220	7	
	3	35630	CWF	30.64	36560			988	-2.07	584	382	2.0	60	3.00	6.50	2	16.75	122	82		180	220	7	
Mar 09	1	34600	CWF	30.60	35800			1003	-2.02	585	404	2.0	60	3.00	6.50	2	16.75	125	79		192	224	8	
	2	36370	CWF	31.11	31220			968	-2.06	585	408	3.0	60	3.00	6.50	2	16.75	124	86		185	220	7	
	3	34530	CWF	29.50	32040			1021	-2.04	565	392	2.0	60	2.00	5.75	2/1	16.75	124	84		180	220	7	
Mar 10	1	34150	CWF	24.16	26040			1042	-2.04	579	403	3.0	60	2.00	6.00	1	16.75	127	81		185	220	7	
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/MFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Mar 11	1																							
	2																							
	3																							
Mar 12	1																							
	2																							
	3																							
Mar 13	1																							
	2																							
	3																							
Mar 14	1																							
	2																							
	3																							
Mar 15	1																							
	2																							
	3																							
Mar 16	1																							
	2																							
	3																							
Mar 17	1																							
	2																							
	3																							
Mar 18	1																							
	2																							
	3																							
Mar 19	1																							
	2																							
	3																							
Mar 20	1																							
	2																							
	3																							

50

Parameter Date	Shift	Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Mar 21	1																							
	2																							
	3																							
Mar 22	1																							
	2																							
	3																							
Mar 23	1																							
	2																							
	3																							
Mar 24	1																							
	2																							
	3																							
Mar 25	1																							
	2																							
	3																							
Mar 26	1																							
	2																							
	3																							
Mar 27	1																							
	2																							
	3																							
Mar 28	1																							
	2																							
	3																							
Mar 29	1																							
	2																							
	3																							
Mar 30	1																							
	2																							
	3																							

Parameter		Steam Flow (lb/hr)	Fuel Type (CWF/NFO)	Fuel Flow (lb/hr)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Date	Shift																							
Mar 31	1																							
	2																							
	3																							

C-1

SHIFT OPERATOR LOG - BOILER #7: Operation with Heavy Fuel Oil at Minas Basin Pulp and Power

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(%)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Mar 01	1	30380	HFO	32.12	36880			68	-2.06	571	374	2.0	60	5.75	2	2	16.75	80	40		190	230	8	
	2	31750	HFO	33.68	36590			72	-1.98	574	378	2.0	60	5.75	2	2	16.75	87	44		190	230	8	
	3	31500	HFO	34.80	36750			65	-2.08	580	379	2.0	60	5.75	2	2	16.75	87	42		190	220	7	
Mar 02	1	31550	HFO	34.06	37200			71	-2.04	584	382	2.0	60	5.75	2	2	16.75	85	42		190	230	7	
	2	25690	HFO	27.58	31400			120	-2.01	521	348	2.0	60	5.75	2	2	16.75	74	33		190	220	7	
	3	26630	HFO	28.63	32000			148	-2.07	522	348	2.0	60	5.75	2	2	16.75	76	31		190	220	6	
Mar 03	1	33060	HFO	35.01	35450			246	-2.06	572	372	3.0	60	5.75	2	2	16.75	120	45		180	220	7	
	2	31510	HFO	33.06	37280			211	-2.03	543	354	2.0	60	5.75	2	2	16.75	86	41		190	220	7	
	3	29500	HFO	31.60	35000			196	-2.04	528	346	2.0	60	5.75	2	2	16.75	82	38		190	220	6	
Mar 04	1	29530	HFO	31.90	35900			201	-2.05	546	353	2.0	60	5.75	2	2	16.75	113	37		180	220	7	
	2	30150	HFO	32.50	36500			212	-2.03	549	355	2.0	60	5.75	2	2	16.75	84	40		190	220	8	
	3	30100	HFO	32.20	36700			208	-2.05	553	356	2.0	60	5.75	2	2	16.75	85	40		195	220	6	
Mar 05	1	31080	HFO	33.40	37500			209	-2.04	563	362	2.0	60	5.75	2	2	16.75	86	40		192	222	7	
	2	30200	HFO	32.60	36500			183	-2.05	563	366	2.0	60	5.75	2	2	16.75	85	40		195	220	6	
	3	31640	HFO	33.45	37500			202	-2.01	569	371	2.0	60	5.75	2	2	16.75	86	40		190	230	7	
Mar 06	1	26380	HFO	26.50	30380			130	-2.04	533	353	2.0	60	5.75	2	2	16.75	75	32		195	220	7	
	2	26280	HFO	25.85	29750			115	-2.05	515	343	2.0	60	5.75	2	2	16.75	73	31		192	222	8	
	3	25720	HFO	26.78	30920			141	-2.05	501	335	1.0	60	5.75	2	2	16.75	74	28		190	220	8	
Mar 07	1	24660	HFO	27.44	31140			395	-2.03	510	338	1.0	60	5.75	2	2	16.75	87	36		195	225	8	
	2	24500	HFO	26.75	30380			543	-2.02	522	357	1.0	60	5.75	2	1	16.75	93	37		195	220	7	
	3	31390	HFO	34.75	38780			539	-2.09	575	385	2.0	60	5.75	2	1	16.75	100	45		190	220	8	
Mar 08	1	28040	HFO	31.58	35480			539	-2.11	579	386	3.0	60	5.75	2	1	16.75	99	43		192	224	8	
	2																							
	3																							
Mar 09	1	28950	HFO	31.33	35420			343	-2.06	545	365	2.0	60	5.75	2	1	16.75	82	36		192	225	8	
	2	32830	HFO	35.82	39800			369	-2.25	598	395	3.0	60	5.75	2	1	16.75	84	36		185	220	7	
	3																							
Mar 10	1	32630	HFO	33.84	37880			316	-2.08	563	371	3.0	60	5.75	2	2	16.75	87	40		185	220	7	
	2	35660	HFO	37.81	41390			369	-2.06	597	387	4.0	60	5.75	2	2	16.75	104	47		180	220	7	
	3	30020	HFO	31.83	36330			300	-2.04	539	363	2.0	60	5.75	2	2	16.75	83	38		180	210	7	

Parameter Date	Parameter Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (%)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Mar 11	1	27350	HFO	29.55	34350			264	-2.06	553	365	2.0	60	5.75	2	2	16.75	79	34		190	225	8	
	2	26500	HFO	28.25	32800			235	-2.01	542	362	2.0	60	5.75	2	2	16.75	76	30		190	220	7	
	3	28000	HFO	28.78	33830			252	-2.06	542	364	2.0	60	5.75	2	2	16.75	78	35		180	220	7	
Mar 12	1	27880	HFO	30.06	34000			260	-2.06	551	370	2.0	60	5.75	2	2	16.75	79	31		195	220	7	
	2	29920	HFO	31.40	35600			278	-2.07	549	369	2.0	60	5.75	2	2	16.75	82	37		180	220	8	
	3	28830	HFO	30.10	34100			264	-2.04	537	363	2.0	60	5.75	2	2	16.75	80	35		190	220	8	
Mar 13	1	32000	HFO	34.30	38500			314	-2.06	590	390	3.0	60	5.75	2	2	16.75	90	41		195	220	7	
	2	33860	HFO	37.40	42600			331	-2.02	613	401	3.0	60	5.75	2	2	16.75	95	44		180	230	8	
	3	33500	HFO	36.60	40300			342	-2.03	601	400	3.0	60	5.75	2	2	16.75	94	46		190	230	8	
Mar 14	1	34250	HFO	35.70	39800			340	-2.03	606	396	3.0	60	5.75	2	2	16.75	92	43		195	220	7	
	2	30300	HFO	32.60	36400			246	-2.06	554	390	3.0	60	5.75	2	2	16.75	85	38		180	220	8	
	3	32690	HFO	32.00	36800			249	-2.02	584	392	3.0	60	5.75	2	2	16.75	84	37		190	230	8	
Mar 15	1	23000	HFO	24.00	26100			259	-2.00	533	363	2.0	60	5.75	2	1	16.75	73	26		190	220	8	
	2	24380	HFO	24.30	37800			274	-2.07	550	373	3.0	60	5.75	2	1	16.75	74	26		190	230	8	
	3	31800	HFO	35.40	40200			375	-2.10	602	404	3.0	60	5.75	2	1	16.75	91	43		190	222	8	
Mar 16	1	25260	HFO	26.70	28800			302	-2.03	551	383	2.0	60	5.75	2	1	16.75	76	27		190	230	8	
	2	24130	HFO	26.00	30100			295	-2.04	548	382	2.0	60	5.75	2	1	16.75	75	27		190	230	8	
	3	30480	HFO	28.90	36600			337	-2.0[illegible]	578	391	3.0	60	5.75	2	1	16.75	86	38		190	222	8	
Mar 17	1	23710	HFO	25.60	26300			271	-2.04	553	382	3.0	60	5.75	2	1	16.75	73	27		190	230	8	
	2	30370	HFO	33.20	37500			293	-1.97	602	404	4.0	60	5.75	2	1	16.75	88	40		180	220	8	
	3	27960	HFO	29.90	33700			308	-1.97	570	389	3.0	60	5.75	2	1	16.75	79	34		190	222	8	
Mar 18	1																							
	2																							
	3																							
Mar 19	1																							
	2																							
	3																							
Mar 20	1	33330	HFO	38.60	40200			337	-2.13	591	390	3.0	60	5.75	2	2	16.75	72	10		195	220	6	
	2	34600	HFO	37.70	41900			538	-1.95	592	396	4.0	60	5.75	2	2	16.75	74	11		192	222	7	
	3	26740	HFO	28.40	32400			245	-2.02	544	369	2.0	60	5.75	2	1	16.75	77	32		190	230	8	

Parameter		Steam Flow	Fuel Type	Fuel Flow	Air Flow	Air Ratio	Oxygen (%)	ATM Steam	Furnace Pres.	Exhaust Temp.	Comb. Air	Windbox Pres.	SecVane Angle	Prim. Damp.	Sec. Damp.	Gun ID	Gun Pos.	ATM Steam	Fuel Pres.	Strain Diff.	FW Pres.	FW Temp.	DA Pres.	Soot-blow
Date	Shift	(lb/hr)	(CWF/HFO)	(%)	(lb/hr)			(lb/hr)	(in)	(F)	Temp(F)	(in)	(deg)	Pos(in)	Pos(in)	#	(in)	(psig)	(psig)	(psid)	(psig)	(F)	(psig)	(min.)
Mar 21	1	28000	HFO	30.50	43400			188	-1.96	543	371	2.0	60	5.75	2	1	16.75	81	37		190	230	8	
	2	30040	HFO	32.70	33100			196	-2.07	576	387	3.0	60	5.75	2	1	16.75	85	41		190	230	8	
	3	29750	HFO	32.00	36100			202	-2.10	566	378	3.0	60	5.75	2	1	16.75	85	40		190	230	8	
Mar 22	1	21690	HFO	24.20	28500			188	-1.96	493	332	2.0	60	5.75	2	1	16.75	76	35		190	230	8	
	2	29710	HFO	32.60	36000			300	-1.89	554	378	3.0	60	5.75	2	2	16.75	89	42		190	230	8	
	3	32630	HFO	34.90	38900			302	-2.01	553	352	3.0	60	5.75	2	2	16.75	91	45		195	220	6	
Mar 23	1	30130	HFO	32.00	36300			287	-1.93	550	368	3.0	60	5.75	2	2	16.75	87	43		190	230	7	
	2	28580	HFO	29.80	35100			300	-2.01	552	372	3.0	60	5.75	2	2	16.75	88	39		190	230	8	
	3	28630	HFO	30.50	34900			262	-2.01	555	366	2.0	60	5.75	2	2	16.75	84	37		195	220	7	
Mar 24	1	33140	HFO	36.00	40100			296	-2.05	584	382	4.0	60	5.75	2	2	16.75	94	48		190	230	8	
	2	30860	HFO	34.10	36700			257	-2.02	557	372	3.0	60	5.75	2	2	16.75	88	41		192	224	8	
	3	24000	HFO	25.50	30000			237	-1.86	522	351	2.0	60	5.75	2	2	16.75	77	30		195	220	8	
Mar 25	1																							
	2																							
	3																							
Mar 26	1																							
	2																							
	3																							
Mar 27	1	24910	HFO	26.90	29700			275	-1.97	521	357	3.0	60	5.75	2	2	16.57	83	34		192	226	8	
	2	34620	HFO	36.90	41400			303	-2.00	581	398	5.0	60	5.75	2	2	16.57	96	51		195	220	6	
	3	41630	HFO	45.00	49500			341	-2.07	614	411	7.0	60	5.75	2	2	16.57	106	59		190	230	8	
Mar 28	1	32010	HFO	34.60	39100			259	-2.10	568	385	3.0	60	5.75	2	2	16.57	90	43		192	226	8	2.0
	2	38570	HFO	41.30	45700			335	-1.66	597	391	7.0	60	5.75	2	2	16.57	100	52		195	220	6	
	3	35250	HFO	38.30	42400			313	-2.11	580	385	5.0	60	5.75	2	2	16.57	97	44		195	220	7	
Mar 29	1	30040	HFO	32.60	37200			300	-2.05	547	369	3.0	60	5.75	2	2	16.57	87	42		195	225	8	
	2	38080	HFO	42.40	46100			352	-2.01	604	396	5.0	60	5.75	2	2	16.57	102	56		190	230	8	
	3	39050	HFO	42.40	46700			359	-1.79	604	372	6.0	60	5.75	2	2	16.57	101	53		195	230	7	
Mar 30	1	34010	HFO	36.80	41100			318	-1.99	576	385	4.0	60	5.75	2	2	16.57	95	47		200	222	8	
	2	34630	HFO	37.60	42100			326	-1.88	583	385	5.0	60	5.75	2	2	16.57	95	51		190	230	8	
	3	37240	HFO	39.90	44100			323	-2.02	596	366	4.0	60	5.75	2	2	16.57	96	47		190	230	8	

Parameter Date	 Shift	Steam Flow (lb/hr)	Fuel Type (CWF/HFO)	Fuel Flow (%)	Air Flow (lb/hr)	Air Ratio	Oxygen (%)	ATM Steam (lb/hr)	Furnace Pres. (in)	Exhaust Temp. (F)	Comb. Air Temp(F)	Windbox Pres. (in)	SecVane Angle (deg)	Prim. Damp. Pos(in)	Sec. Damp. Pos(in)	Gun ID #	Gun Pos. (in)	ATM Steam (psig)	Fuel Pres. (psig)	Strain Diff. (psid)	FW Pres. (psig)	FW Temp. (F)	DA Pres. (psig)	Soot-blow (min.)
Mar 31	1	31710	HFO	33.90	38100			283	-2.06	566	384	3.0	60	5.75	2	2	16.57	90	43		190	230	8	
	2	38880	HFO	42.10	46300			341	-1.81	616	402	5.0	60	5.75	2	2	16.57	103	54		195	220	7	
	3	37830	HFO	40.50	44500			306	-2.11	604	359	4.0	60	5.75	2	2	16.57	99	49		195	220	7	

55

APPENDIX J

NSRF CWF FLYASH CHARACTERIZATION REPORT

CHARACTERIZATION OF THE COAL-WATER FUEL FLY-ASH EMISSIONS FROM THE MINAS BASIN PULP AND PAPER STEAM BOILER

BY

NEIL STOVER

May, 1989

A PROJECT FUNDED BY THE CANADA NOVA SCOTIA OIL SUBSTITUTION AND CONSERVATION AGREEMENT

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TABLE OF CONTENTS

PAGE

LIST OF FIGURES ii

LIST OF TABLES iii

LIST OF SCANNING ELECTRON MICROSCOPE MICROGRAPHS iv

ABSTRACT v

1 INTRODUCTION 1

2 EXPERIMENTAL 1

3 RESULTS AND DISCUSSION 2

4 CONCLUSIONS 11

ACKNOWLEDGEMENTS 12

REFERENCES 13

LIST OF FIGURES

		PAGE
Figure 1	Particle Size Distribution For the Stack Samples Using Hand Sieve + Coulter	15
Figure 2	Particle Size Distribution For the Stack Samples Using Microtrac	15
Figure 3	Particle Size Distribution For the Stack Samples Using Coulter	16
Figure 4	Comparison of Particle Sizing Methods for Test # 1 Stack Sample	16
Figure 5	Multicyclone Aerodynamic Sizing for the Stack Particles	17
Figure 6	Particle Size Distribution for Hopper Samples Using Hand Sieve	17
Figure 7	Particle Size Distribution for Hopper Samples Using Coulter	18
Figure 8	Comparison of the Atomized CWF Spray PSD and the CWF Ash PSD	18

LIST OF TABLES

PAGE

Table 1 Summary of the Boiler Operating Conditions 2

Table 2 CWF Properties 3

Table 3 Stack Gas Particulate Loading and Ash Mass Flows 4

Table 4 Carbon, Sulphur, Ash and Hydrogen Analysis of the Ash Samples 6

Table 5 Bulk Density of Stack Particles by Mercury Pycnometer 8

Table 6 Material Density of Stack Particles by Helium Pycnometer 8

Table 7 Differential Thermal Analysis of the Ash 10

LIST OF SCANNING ELECTRON MICROSCOPE MICROGRAPHS

		PAGE
Photo 1	SEM Micrograph of Stack # 1, < 45 μm Sample	19
Photo 2	SEM Micrograph of Stack # 1, 45 to 106 μm Sample	19
Photo 3	SEM Micrograph of Stack # 1, > 106 μm Sample	20
Photo 4	SEM Micrograph of Stack # 2, < 45 μm Sample	20
Photo 5	SEM Micrograph of Stack # 2, 45 to 106 μm Sample	21
Photo 6	SEM Micrograph of Stack # 2, > 106 μm Sample	21
Photo 7	SEM Micrograph of Stack # 3, < 45 μm Sample	22
Photo 8	SEM Micrograph of Stack # 3, 45 to 106 μm Sample	22
Photo 9	SEM Micrograph of Stack # 3, > 106 μm Sample	23
Photo 10	SEM Micrograph of Stack # 4, < 45 μm Sample	23
Photo 11	SEM Micrograph of Stack # 4, 45 to 106 μm Sample	24
Photo 12	SEM Micrograph of Stack # 4, > 106 μm Sample	24
Photo 13	SEM Micrograph of Hopper # 1, < 45 μm Sample	25
Photo 14	SEM Micrograph of Hopper # 1, 45 to 106 μm Sample	25
Photo 15	SEM Micrograph of Hopper # 1, > 106 μm Sample	26
Photo 16	SEM Micrograph of Hopper # 2, < 45 μm Sample	26
Photo 17	SEM Micrograph of Hopper # 2, 45 to 106 μm Sample	27
Photo 18	SEM Micrograph of Hopper # 2, > 106 μm Sample	27
Photo 19	SEM Micrograph of Hopper # 3, < 45 μm Sample	28
Photo 20	SEM Micrograph of Hopper # 3, 45 to 106 μm Sample	28
Photo 21	SEM Micrograph of Hopper # 3, > 106 μm Sample	29
Photo 22	SEM Micrograph of Hopper # 4, < 45 μm Sample	29
Photo 23	SEM Micrograph of Hopper # 4, 45 to 106 μm Sample	30
Photo 24	SEM Micrograph of Hopper # 4, > 106 μm Sample	30

ABSTRACT

The particulate emissions from a coal-water fuel (CWF) fired industrial steam boiler have been characterized. The boiler was operated at two CWF firing rates and excess oxygen levels in the flue gas. Particulate samples have been taken from the flue gas and the air preheater hopper. Stack gas particulate loadings ranged from 2 to 3.7 g/Nm^3. The carbon content of the fly ash was found to vary from 31 percent in the $< 45\ \mu m$ size range to 81 percent in the $> 106\ \mu m$ range. A good portion of the ash was comprised of high carbon, hollow cenospheres that were readily entrained by the gas flow through the boiler. Although overall fuel burnout efficiencies in the 96 - 98% range were measured, it is apparent that the high particulate emissions could be reduced by improved atomization to minimize oversize spray droplets that are precursors to the formation of the coarse hollow cenospheres.

1 INTRODUCTION

The conversion of the Minas Basin Pulp and Power Company boiler to CWF has resulted in the emission of particulates at a rate of between 2 and 3.5 g/Nm^3 of flue gas. The location of the boiler near a residential area makes the particulate emission rates unacceptable, particularly when the wind direction carries the particulates over the town. The Nova Scotia Research Foundation Corporation (NSRFC) has been contracted by the Cape Breton Development Corporation (CBDC) to characterize the particulate emissions. Collection of the particulates was carried out at two CWF firing rates and two excess oxygen levels for each firing rate. The characterization of the particulates was done to optimize the design data generated for a cyclone collection system. The boiler was operated at steady state conditions, as much as the steam requirements would allow, for each test period. Each test period spanned approximately six hours.

2 EXPERIMENTAL

2-1 The Boiler

The boiler, at the Minas Basin Pulp and Power Company, in this study is a balanced draft, oil-designed unit with a maximum steam production capacity of 27,000 kg/hr at 120°C (1). The steam is used to provide process heat for industrial grade paper production. The fuel is fired with a single prefilming steam blast, dual oil/CWF atomizer. The steam to CWF ratio is controlled using the relative pressure of the two streams. During the ash sampling tests, primary and secondary air were preheated to 140°C and introduced around the atomizer. Preheated tertiary air was introduced through eight separate staging air ports located radially around the burner. The flame travels down the boiler and turns 180° through a tube bank. The gas then turns 90° towards the air preheater. A hopper is located upstream of the preheater prior to the stack. No particulate collection equipment was in place. Particulate samples were collected from the hopper and in the flue gas through a port approximately 10 m up the stack. Stack gas temperature and velocity measurements were made at the 10 m port.

2-2 Particulate Sampling Systems and Gas Analysis

The stack particulate loadings and aerodynamic sizing was carried out using a Sierra Instruments Inc., Series 280 in-stack cascade cyclone sampler (2). The Sierra multi-cyclone device had four cyclones in series followed by a total filter. The aerodynamic size of the particulates is determined based on the cyclone dimensions and the gas viscosity, density and velocity. Bulk fly ash samples, for subsequent analysis, were collected isokinetically at the 10 m port using a 33 cm^2 sample probe. The flue gas was drawn into a preheated fibreglass bag filter where the particulate was removed. The flue gas velocity was monitored regularly using a pitot tube, and the sample rate adjusted accordingly. The flue gas O_2 and CO_2 concentrations were determined using wet chemistry methods. The samples were removed from the hopper using a vacuum lock system.

2-3 Particulate Analysis Equipment

Particle size distribution (PSD) analysis was carried out using Coulter counter, Microtrac and hand sieves. Carbon and hydrogen analysis was done on a Leco CHN-600 analyzer. Sulphur concentrations were measured using a Leco sulphur analyzer. Particle bulk densities were determined using a mercury pycnometer and the material densities using a helium pycnometer.

3 RESULTS AND DISCUSSION

3-1 Boiler Operational Data and CWF Analysis

Boiler Operational Data

The boiler was operated at two CWF firing rates, the higher rate corresponding to the uptake of steam by the paper process, and the lower rate turned down by approximately twenty percent. Table 1 shows the operating conditions during fly-ash sampling.

Table 1, Summary of the Boiler Operating Conditions

TEST ID #	CWF FIRING RATE (kg/hr)	O_2 (%)	CO_2 (%)	STACK TEMP. (deg C)	STACK GAS VEL. (m/s)
1	1556	3	14.5	159	3.3
2	1535	6	12	161	4.5
3	1140	6	13	143	3.7
4	1292	8	11	148	3.2

The desired O_2 levels in the flue gas were 3 and 5%. Variations in the actual levels were primarily due to changes in the steam demand at the plant. Steady state operation was maintained throughout the ash sampling period.

CWF analysis

The tests were carried out in a period spanning five days during which six, thirty tonne truck loads of CWF were delivered. Table 2 shows the analysis of each of the six truck loads of CWF. The relative variations in the ash, sulphur, Btu/lb, moisture and specific gravity are insignificant. The lower viscosity (at 100 s^{-1}) increases then decreases. This may affect the atomization of the CWF. The flow rate of the atomization steam is controlled in relation to the delivery pressure of the CWF.

Table 2, CWF Properties

SHIPMENT DATE	ASH (%)	SULPHUR (%)	BTU/lb dry	MOISTURE (%)	S.G.	VISCOSITY	
						UPPER (cp)	LOWER (cp)
24/9/88	3.54	1.61	14,908	30.22	1.200	1010	610
26/9/88	3.62	1.65	14,842	30.21	1.200	985	670
26/9/88	3.69	1.70	14,776	30.20	1.195	960	730
27/9/88	3.67	1.70	14,827	30.21	1.191	1200	770
28/9/88	3.83	1.72	14,862	30.27	1.194	1200	730
29/9/88	3.67	1.68	14,740	30.33	1.186	1700	700
AVERAGE	3.67	1.68	14,826	30.24	1.194	1176	702
STD DEV	0.09	0.04	55	0.05	0.005	254	51

The CWF is made with a high volatile bituminous A coal from Cape Breton, Nova Scotia, Canada with a FSI of 5 to 7.

3-2 Ash Mass Flow

The stack gas fly-ash loadings shown in Table 3, as determined by the multi-cyclone stack sampler, varied from 2 to 3.6 g/Nm^3. The ash fraction in these particulate loadings represent 57 to 92 percent of the ash input (3). The flue gas particulate loadings were highest at the lowest excess air levels (tests 1 and 3) and were comparable to the concentrations reported in the literature (4,5).

Table 3, Stack gas particulate loading and ash mass flows

Test # --------	STACK GAS PARTICLE LOADING (g/Nm^3) --------	ASH OUT IN FLUE GAS (%) -------	ASH OUT AT AIR PREHEATER (%) -------	DEPOSITED IN BOILER by difference (%) -------
1	3.6580	67.8	10.5	21.7
2	2.0886	66.2	2.5	31.3
3	3.3675	92.1	2.4	5.5
4	2.9761	57.5	15.8	26.7

The data determined for the ash out in the air preheater hopper is questionable. Difficulty was encountered in removing the samples from the hopper due to the negative pressure. This puts the data on the deposit rate in the boiler in question also. It is unlikely that up to 31% of the ash input to the boiler would be deposited in the boiler. The boiler is not cleaned on a regular basis and these rates of deposit would result in ash build-ups that far exceed those seen.

3-3 Ash Analysis

3-3-1 SEM Photos

Scanning electron micrographs of the particulate samples were taken to allow an examination of the particle morphology. Photo's were taken of the flue gas and hopper particulate material. In each case the material was hand sieved into three size ranges prior to taking the photos. The ranges are < 45 μm, 45 to 106 μm and > 106 μm. The particle morphology was similar for each of the size ranges for either the stack or hopper samples.

Stack Particle SEM Analysis

Photo's 1 to 12 show the three size ranges for each of the four stack samples. The < 45 μm size range was primarily comprised of angulated porous particles and fused ash particles. These particles have high ash contents (< 65%). The 45 to 106 μm range is made up of fractured cenospheres that may have been produced during the sieving operation. The > 106 μm range has more intact cenospheres made of primarily carbon. Faramayan (6), Perkins (4), Sato (7) and Rini (8) have reported the presence of hollow cenospheres. Faramayan (4) showed that the cenosphere diameter increases with an increased distance from the burner. Sato (7) has determined that the cenospheres originate from fine coal particles in the CWF spray. This supports the theory that the cenospheres are formed from the oversized droplets produced by the CWF atomizer (9,10). During the combustion process the larger CWF droplets would dry. This would be followed by the remaining coal particles reaching the temperature where the high FSI of the coal results in the coal particles fusing together. The large CWF droplet would by this time have travelled away from the flame and a large portion of the original carbon would remain unburnt. The combined effect of the particle size, shape and density produced fly ashes which were readily entrained by the flue gas.

Test 3 at lower CWF firing rate and low excess air produced very thin walled cenospheres as can be seen in photo 9.

Hopper Particulate SEM Analysis

Photographs 13 to 24 show the SEM photos for the hopper material. As with the stack samples, the morphological trends for all of the hopper samples in the same size ranges were similar from test to test. The < 45 μm portion contains fused and porous particles with high ash content. The > 106 μm portion contains mostly intact, large (ie > 200 μm), high carbon cenospheres. The 45 - 106 μm portion is made up of a mixture of intact and broken cenospheres. As with the stack samples, some of the 45 - 106 μm portion was partially produced during the sieving operation. The high density, small diameter particles and the very large, low density particles were removed by inertial separation and settling in the air preheater hopper.

3-3-2 Ash and Elemental Analysis

Particulate samples from the flue gas and the air preheater hopper were analyzed for carbon, sulphur, ash and hydrogen. This analysis was also performed on ash samples separated into the < 45, 45 - 106 and > 106 μm sieve fractions. The results are shown in Tables 4a & 4b. The sample identification code is as follows; S - stack sample, H - air preheater sample and # indicates the test number.

Table 4a, Carbon, Sulphur, Ash and Hydrogen Analysis of the Ash Samples

SAMPLE ID	WT. % OF TOTAL (SIEVED)	CARBON (%)	SULPHUR (%)	ASH (%)	HYDROGEN (%)	SUM (%)
S1 < 45	75.8	30.8	0.9	63.2	0.35	95.3
S1 45-106	20.6	62.9	0.9	34.2	0.46	98.4
S1 > 106	3.7	81.1	0.9	12.9	0.60	95.5
Weighted composite		39.2	0.9	55.4	0.38	95.9
S1 representative		45.4	0.9	51.1	0.42	97.8
S2 < 45	81.2	30.3	-	63.2	0.36	93.8
S2 45-106	16.1	41.4	-	54.4	0.33	96.1
S2 > 106	2.8	78.9	-	16.7	0.63	96.2
Weighted composite		33.4	0.0	60.5	0.36	94.3
S2 representative		32.4	1.0	63.8	0.35	97.4
S3 < 45	77.1	35.0	-	58.9	0.36	94.3
S3 45-106	19.2	57.9	-	37.1	0.13	95.1
S3 > 106	3.8	83.9	-	4.8	1.16	89.8
Weighted composite		41.2	0.0	52.7	0.35	94.3
S3 representative		45.8	1.3	48.0	0.67	95.7
S4 < 45	72.6	37.6	-	58.0	0.39	96.0
S4 45-106	21.7	54.4	-	42.3	0.36	97.0
S4 > 106	5.6	84.6	-	11.0	0.57	96.2
Weighted composite		43.9	0.0	51.9	0.39	96.2
S4 representative		50.5	0.9	45.4	0.15	96.9

The carbon content increases with the particle size for all of the stack samples (7). The carbon content (32 to 50%) of the fly-ash increased as the CWF firing rate and the flue gas oxygen was decreased (4,11). The fly-ash is composed primarily of carbon and ash, resulting in the ash content trends that are the reverse of the carbon concentration trends. Some unburnt volatile material remained in the fly-ash as indicated by the presence of hydrogen. Flame temperature, spray drop size and residence time in the flame (12) will effect the unburnt volatile matter remaining in the ash.

Table 4b, Carbon, Sulphur, Ash and Hydrogen Analysis of the Ash Samples (Continued)

SAMPLE ID	WT. % OF TOTAL (SIEVED)	CARBON (%)	SULPHUR (%)	ASH (%)	HYDROGEN (%)	SUM (%)
H1 < 45	28.9	8.0	-	91.1	0.10	99.1
H1 45-106	31.6	38.6	-	68.5	0.27	107.3
H1 > 106	39.5	80.7	-	20.8	0.53	102.1
Weighted composite		46.4	0.0	56.2	0.32	102.9
H1 representative		34.4	0.6	58.8	0.27	94.1
H2 < 45	46.9	1.8	-	98.5	0.05	100.3
H2 45-106	40.5	12.6	-	85.1	0.11	97.8
H2 > 106	12.6	66.7	-	30.6	0.50	97.8
Weighted composite		14.4	0.0	84.5	0.13	99.0
H2 representative		16.0	0.3	80.1	0.14	96.6
H3 < 45	18.6	11.0	-	88.8	0.12	99.8
H3 45-106	23.5	67.0	-	41.5	0.50	109.0
H3 > 106	57.9	85.6	-	17.6	0.69	103.9
Weighted composite		67.4	0.0	36.4	0.54	104.3
H3 representative		54.0	0.8	36.1	0.43	91.4
H4 < 45	34.7	3.6	-	96.2	0.07	99.9
H4 45-106	33.2	37.9	-	68.8	0.36	107.1
H4 > 106	32.1	71.7	-	17.5	0.56	89.8
Weighted composite		36.9	0.0	61.8	0.32	99.0
H4 representative		35.3	0.6	52.3	0.30	88.6

Tables 4a & b show the results determined from the carbon analysis of the unsieved samples and those determined for a weighted composite of the material collected in the different sieve fractions. In most cases the results for the weighted composite and unsieved samples agree reasonably well.

3-3-3 Bulk Density of the Stack Particles

The bulk density of the particulate material sampled from the stack was determined using a mercury pycnometer and is shown in Table 5. The samples were divided into the same size ranges used in the SEM analysis. The < 45 μm size range particles, which comprised the majority of the sample, had the highest bulk density of the three size ranges for all four tests. The packing density of these irregular shaped, variable size particles (see Photos 1, 4, 7 and 10) would also be expected to be high.

Table 5, Bulk Density of Stack Particles by Mercury Pycnometer

	Sample			
	S1	S2	S3	S4
Size Range	(gm/cc)	(gm/cc)	(gm/cc)	(gm/cc)
< 45 μm	0.4669	0.5387	0.3545	0.3558
45-106 μm	0.2444	0.3129	0.2040	0.2706
> 106 μm	0.2075	0.2045	0.1150	0.1800

3-3-4 Density of the Stack Particle Material

The density of the material in the stack fly-ash was determined using a helium pycnometer (Table 6). For all of the tests the density was highest for the < 45 μm size range and lowest for the > 106 μm range. The presence of higher amounts of ash particles with a lower porosity contributes to the higher material density. The material in the > 106 μm size range is made up of highly porous material with large internal cavities.

Table 6, Material Density of Stack Particles by Helium Pycnometer

	Sample			
	S1	S2	S3	S4
Size Range	(gm/cc)	(gm/cc)	(gm/cc)	(gm/cc)
< 45 μm	2.5029	2.5039	2.5818	2.3856
45-106 μm	2.1679	2.2462	2.1314	2.2280
> 106 μm	2.1400	2.1905	2.1498	1.9342

3-3-5 Particle Size Distribution

The particle size distribution (PSD) data for the stack particles collected using the bag filter was determined using three methods; hand sieving plus a single aperture in a Coulter counter, a Microtrac and three apertures in a Coulter counter. The respective data are shown in Figures 1, 2 and 3.

The hand sieve plus Coulter counter method (Figure 1) shows a step in the PSD data at the 45 μm size where the transition from hand sieve to Coulter methods takes place. The step may be partly due to the fracturing of the fragile cenospheres during the sieving process. The Microtrac data (Figure 2) shows a smooth distribution throughout the PSD range.

Figure 4 shows a comparison of the three methods used for the test #1 stack particulate material. The Microtrac method shows the most fine particles (< 106 μm). The 3 tube Coulter method shows the least amount of particles below the 10 μm size. The hand sieve plus Coulter method shows the least amount of particles < 106 μm. This may be due to the fracturing of the larger fragile cenospheres during the sieving process.

For any of the methods, the PSD for the stack samples show only minor differences. For test number 2 there is a slight increase in the amount of particles < 120 μm. The spray drop PSD, flame temperature (11), particle-in-flame residence time and the coal free swelling index will effect the ash PSD.

The result of the in situ multi-cyclone aerodynamic sizing of the stack fines is shown in Figure 5. The weight percent falling in the < 6 μm size varied from 20 to 50 percent.

Two methods were used to determine the PSD of the hopper material. Figure 6 shows the PSD data generated using hand sieving and Figure 8 using three apertures in a Coulter counter. The variation in the PSD of the hopper particles is much greater than that seen in the stack samples. Test number 2 produced the finest particles and test number 3 the coarsest.

Figure 8 compares the combined air heater hopper and flue gas particulate PSD with the PSD of the atomized CWF spray. The CWF spray PSD was determined under similar atomization conditions in an ambient environment (13). With an allowance for swelling and fragmentation of the char cenospheres, the PSD of the ash bears a greater resemblance to the PSD of the CWF spray droplets as opposed to the PSD of the parent coal in the CWF (6,7,11).

3-3-6 Combustibility of the Particles

To quantify any potential combustion hazard associated with the handling of the fly-ash, differential thermal analysis was carried out on the ash samples. Table 7 shows the results from tests in atmospheres with 5 and 21 percent oxygen which simulates in situ and ambient handling. In all cases the onset of oxidation was at temperatures greater than 450°C, indicating that a combustion hazard does not exist during handling or disposal of the fly ash.

Table 7, Differential Thermal Analysis of the Ash

Sample #	Temperature of Onset of Oxidation (5% 02)	(21% 02)
S1	487	469
S2	476	485
S3	457	474
S4	482	455
H1	493	492
H2	508	516
H3	474	475
H4	485	477

3-3-7 Resistivity of the Particles

The resistivity of the stack fly ash was measured and were in a range greater than 10^7 ohm-cm. This data indicates that the fly ash could be removed in electrostatic precipitators. However, as a cost effective measure, it would be more practical to use high efficiency cyclones or bag filters for fly ash collection. The aerodynamic particle size distribution of the stack fly ash in Figure 2 shows that between 50 - 80% of particulates could be removed in high efficiency cyclones with an aerodynamic cut-off diameter > 5.5 μm.

3-3-7 Carbon Combustion Efficiency

The unburnt carbon in the unsieved stack fly ash samples (Table 4) may be used to estimate the overall fuel burn out efficiency in the boiler for a low ash coal-water fuel; the fractional full burn out efficiency, Cx, may be calculated by the following formula (14).

$$Cx = \frac{1 - Ao/A}{1 - Ao}$$

Where Ao is the ash fraction in the dry coal and A is the ash fraction (or 1 - A the carbon fraction) in the fly ash. For Ao = 0.037 (Table 2) and 1 - A = 0.32 - 0.5 (Table 4), percent full burnout efficiencies in the 96 - 98% range were calculated for the 4 tests. Thus, the carbon in ash values measured in the tests, although high, is a feature that arises from the initially low ash content in the CWF. Analogous trends are often found in the high carbon content soot emissions from oil-fired boilers.

4. CONCLUSIONS

- Improved atomization of the CWF would reduce the relative amount of the large droplets of CWF which would in turn result in a reduction in the formation of large cenospheres that are carried in the flue gas as particulate emissions. Improved atomization and combustion would also reduce the emission levels.

- The auto ignition properties of the stack and air preheater hopper particulate material is low and should not pose any problem when handling the material.

- Care should be exercised when choosing a particle sizing method. Sieving of the friable cenospheres causes a change in the particle size distribution. Considerable variation is seen in the < 100 μm size range accuracy of the Coulter counter and Microtrac equipment.

- Aerodynamic characterization of the particulate using an in situ multi-cyclone device indicates that between 60 and 75 percent of the particulates in the flue gas could be collected using a high efficiency multi-cyclone system.

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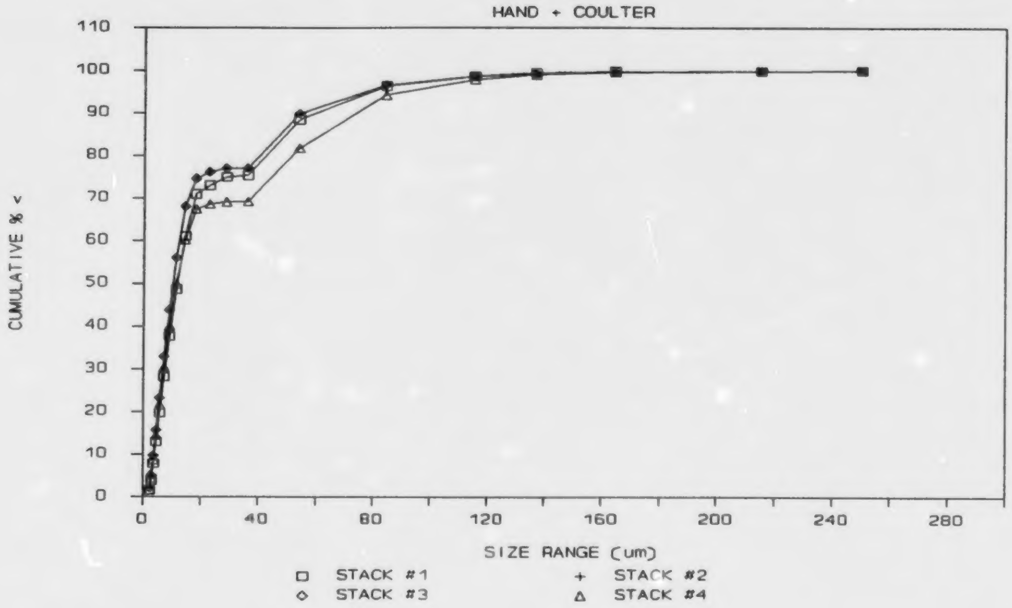

Figure 1, Particle Size Distribution for the Stack Samples
Using Hand Sieve + Coulter

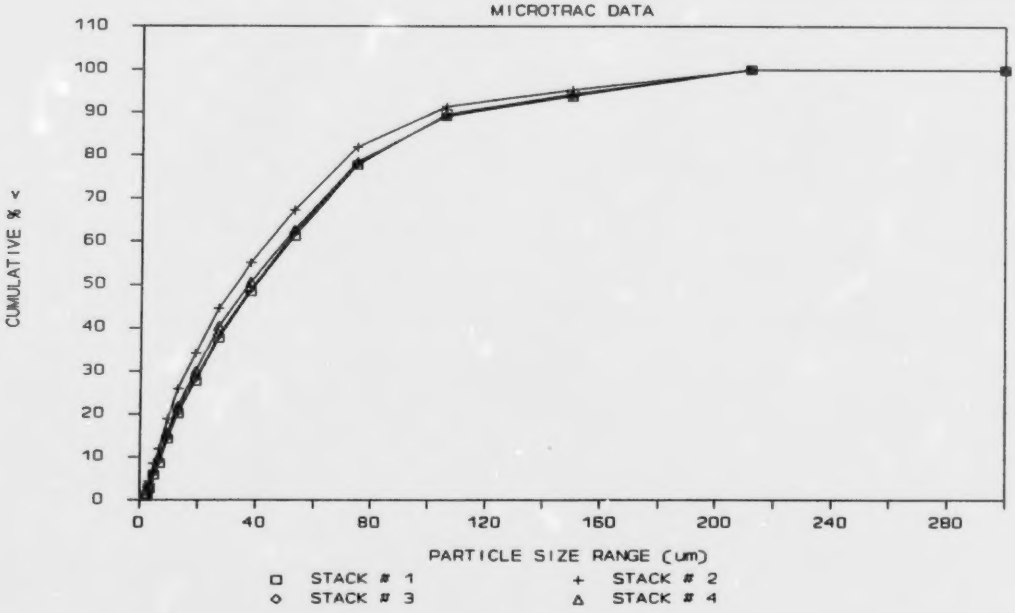

Figure 2, Particle Size Distribution for the Stack Samples
Using Microtrac

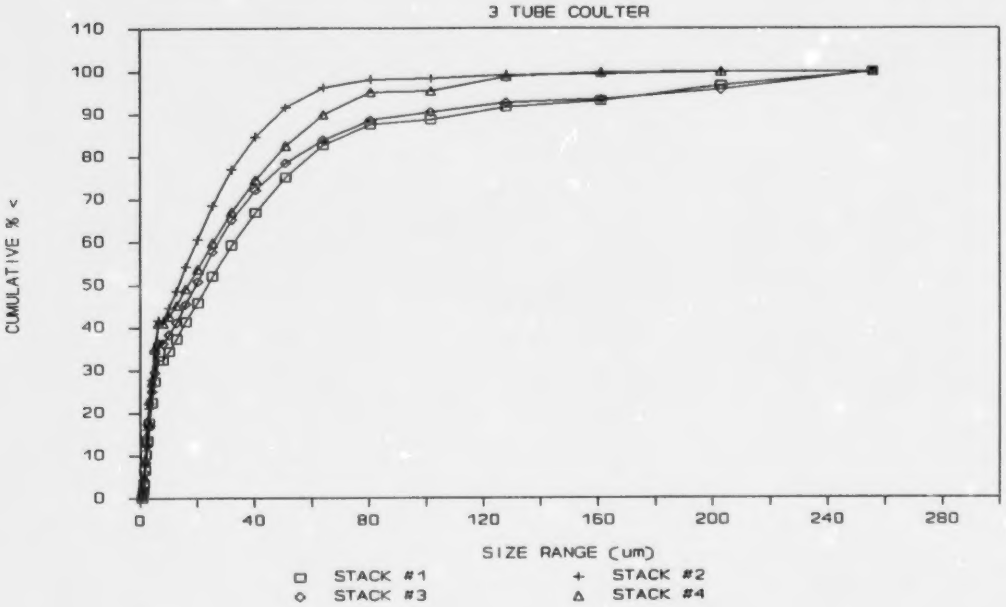

Figure 3, Particle Size Distribution for the Stack Samples Using Coulter

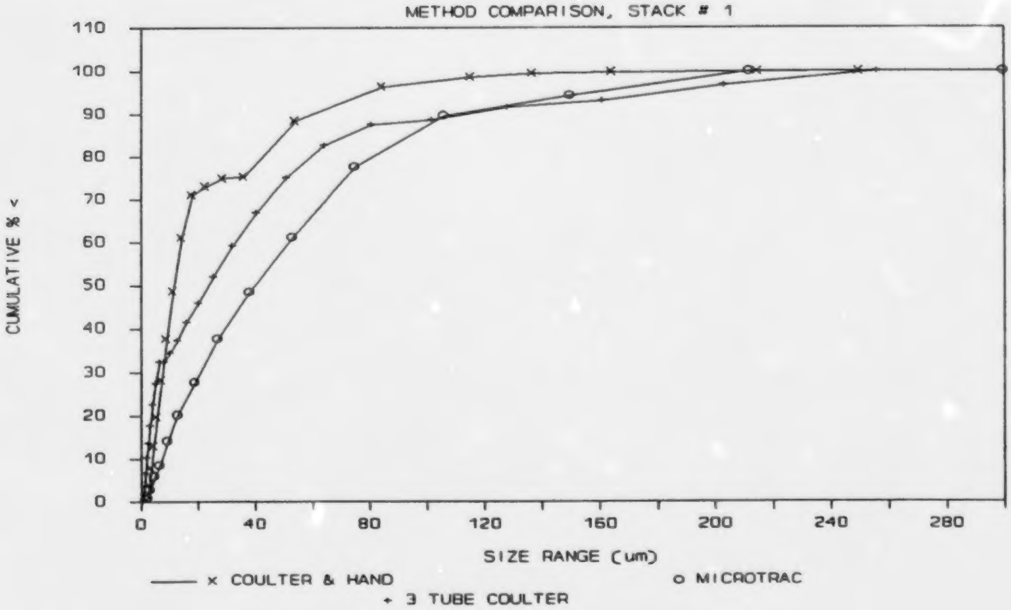

Figure 4, Comparison of Particle Sizing Methods for Test # 1 Stack Sample

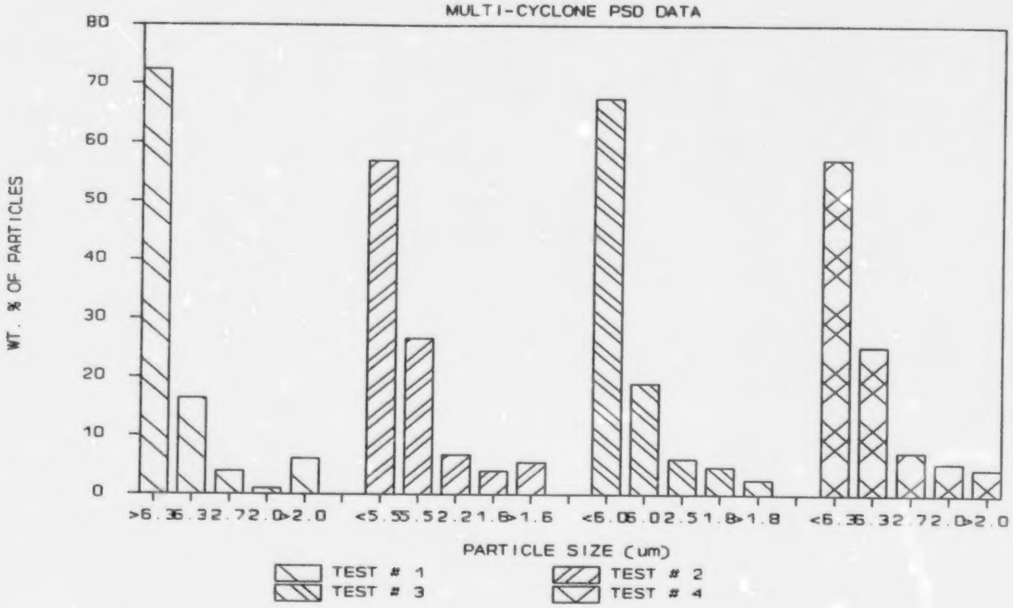

Figure 5, Multicyclone Aerodynamic Sizing for the Stack Particles

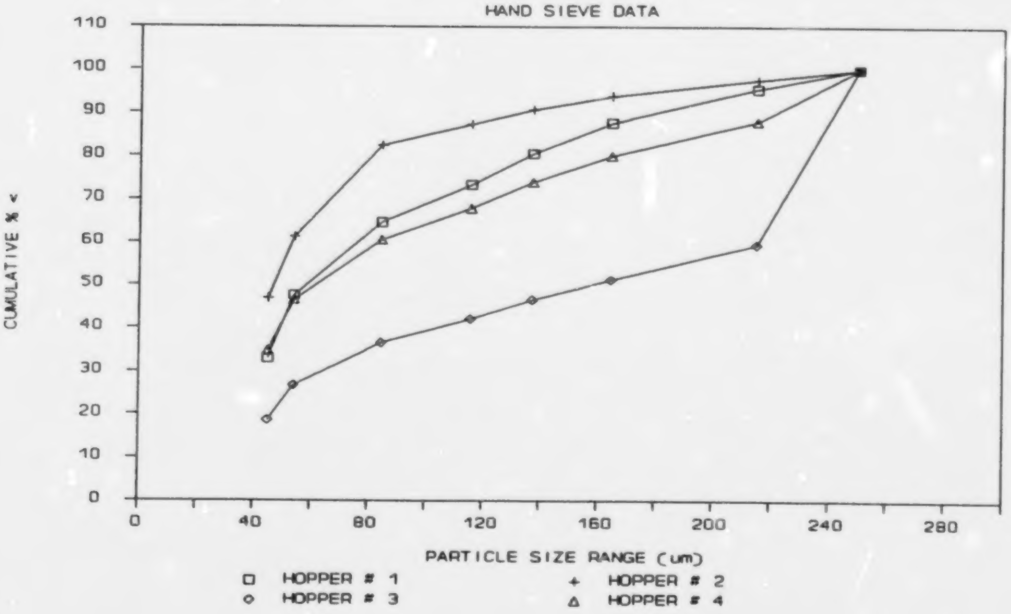

Figure 6, Particle Size Distribution for Hopper Samples
Using Hand Sieve

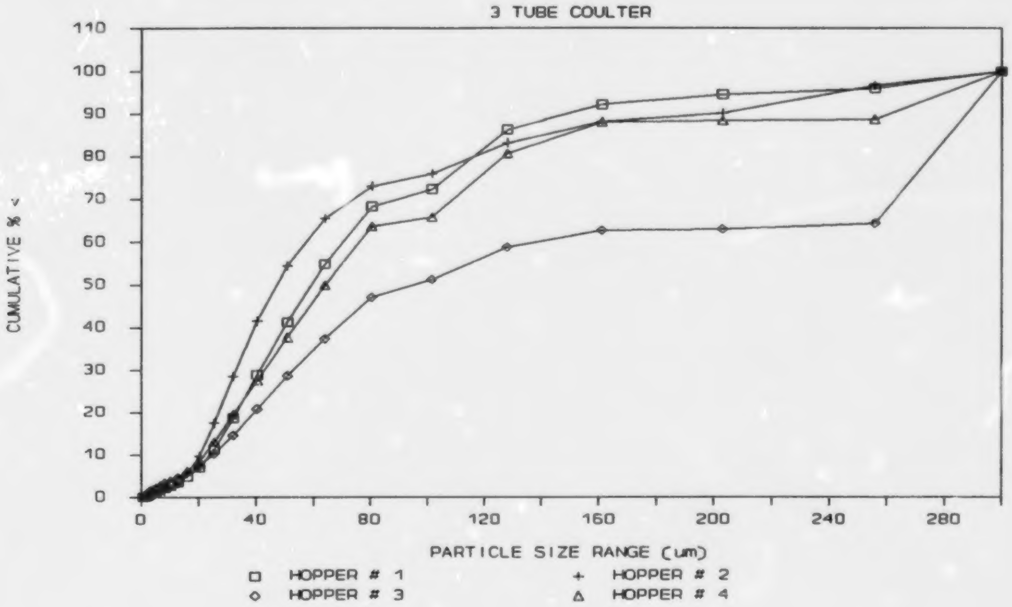

Figure 7, Particle Size Distribution for Hopper Samples Using Coulter

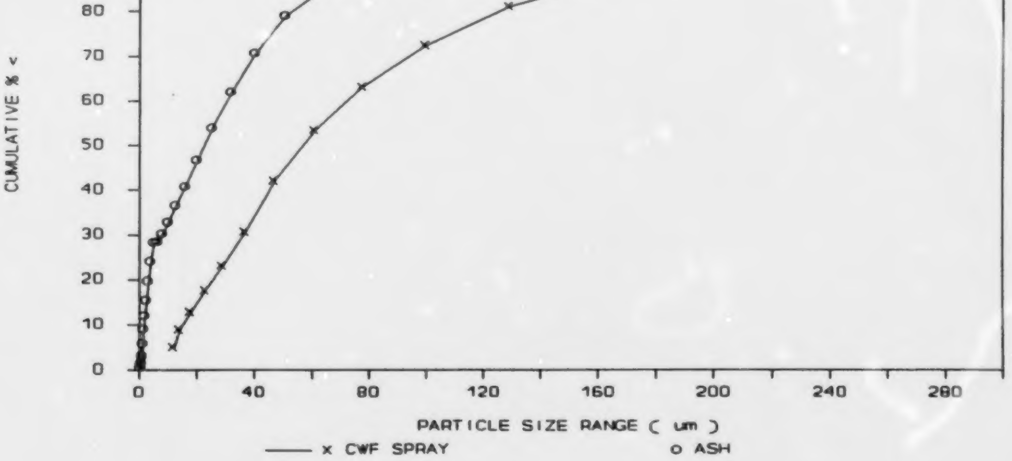

Figure 8, Comparison of the Atomized CWF Spray PSD and the CWF Ash PSD

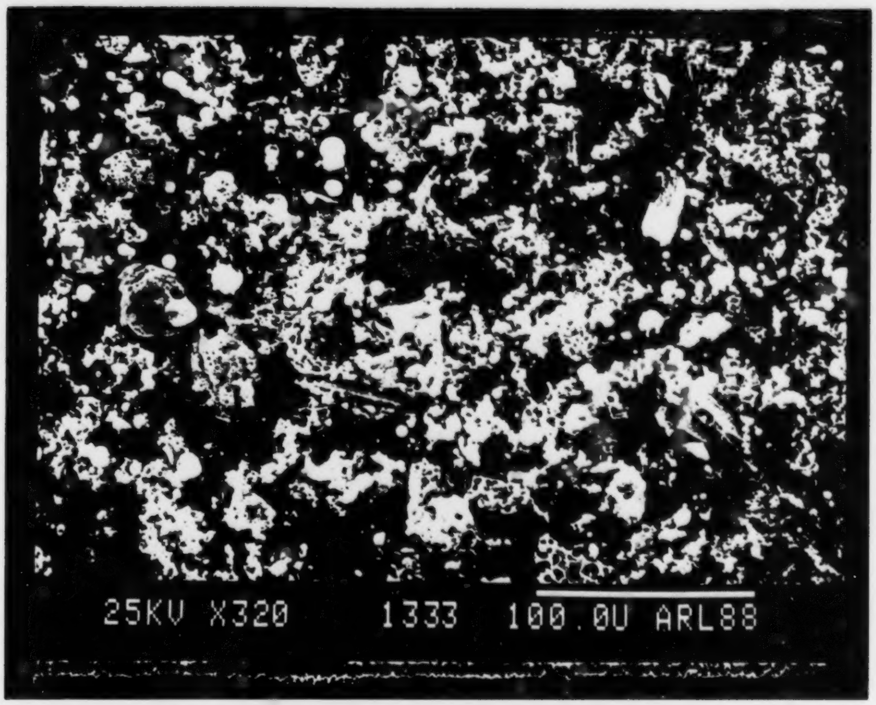
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Photo 1, SEM Micrograph of Stack # 1, < 45 μm Sample

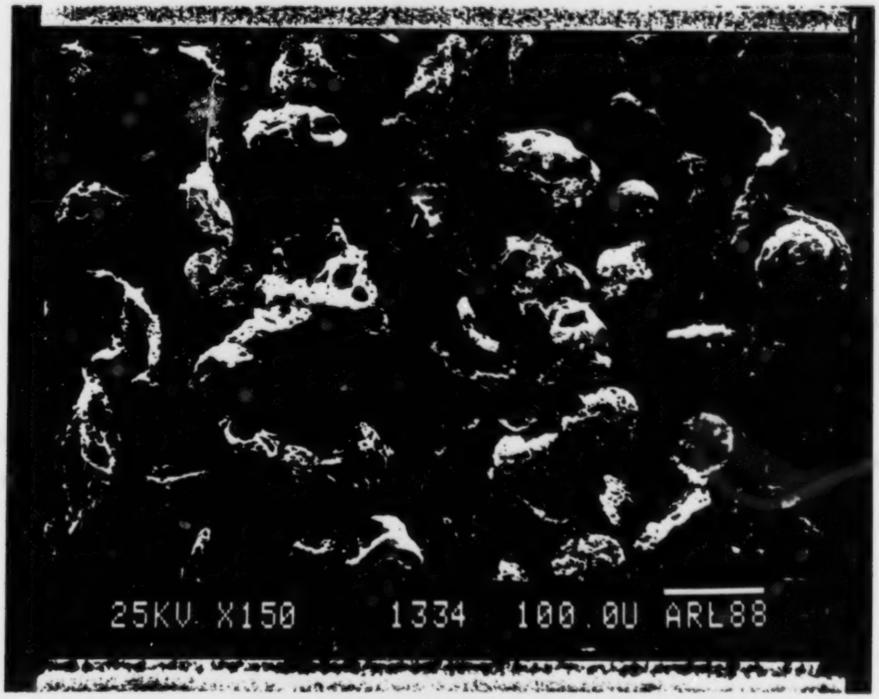
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Photo 2, SEM Micrograph of Stack # 1, 45 to 106 μm Sample

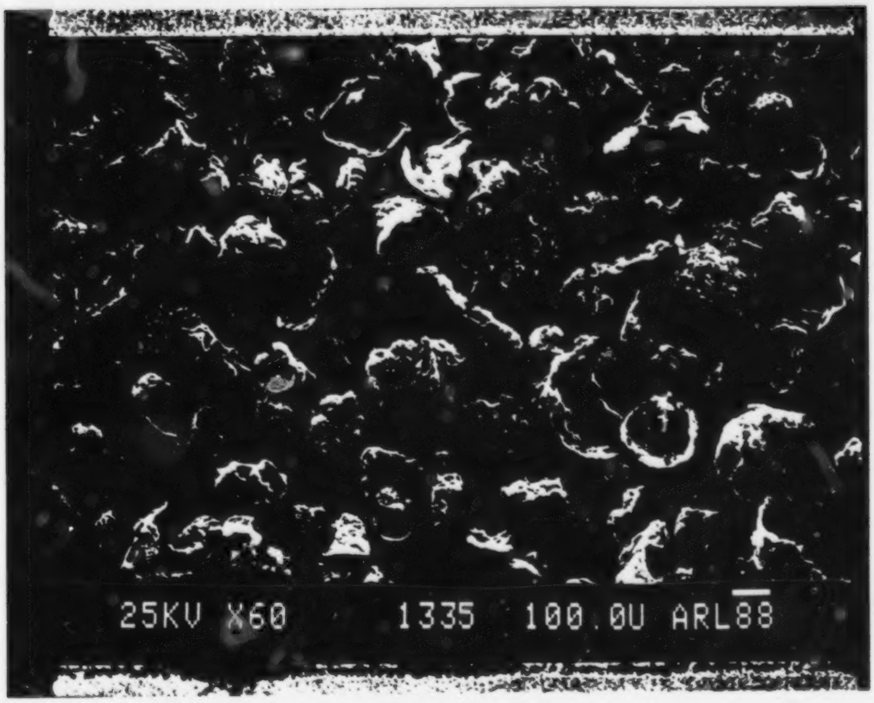
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Photo 3, SEM Micrograph of Stack # 1, > 106 μm Sample

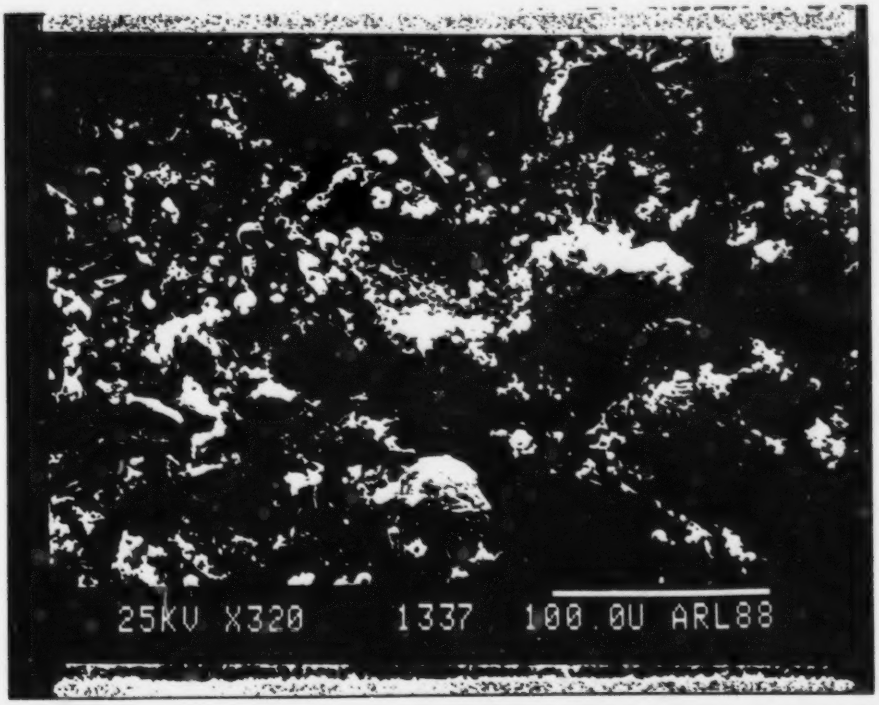
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Photo 4, SEM Micrograph of Stack # 2, < 45 μm Sample

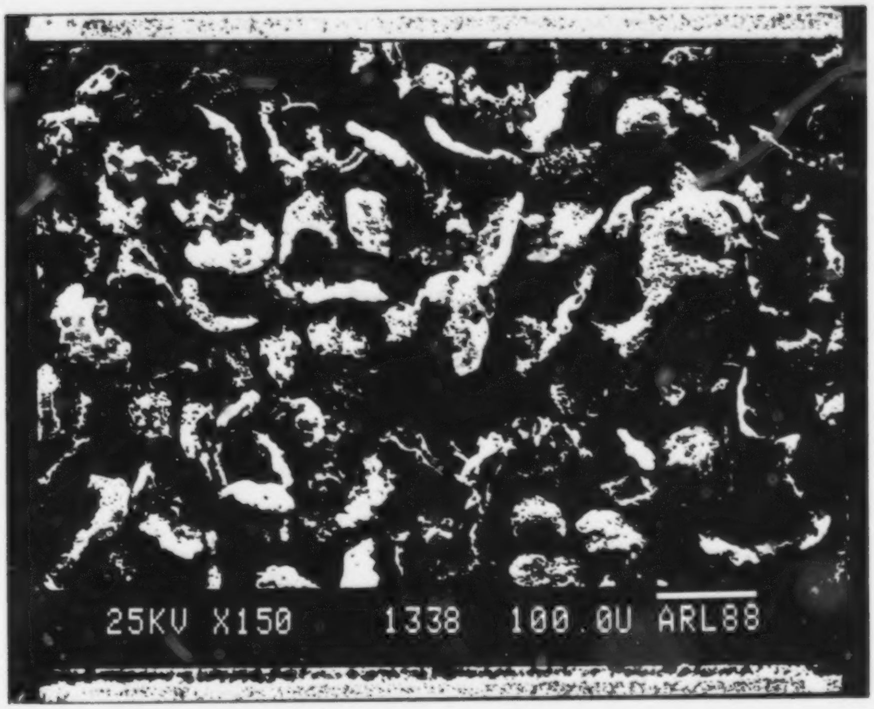
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Photo 5, SEM Micrograph of Stack # 2, 45 to 106 μm Sample

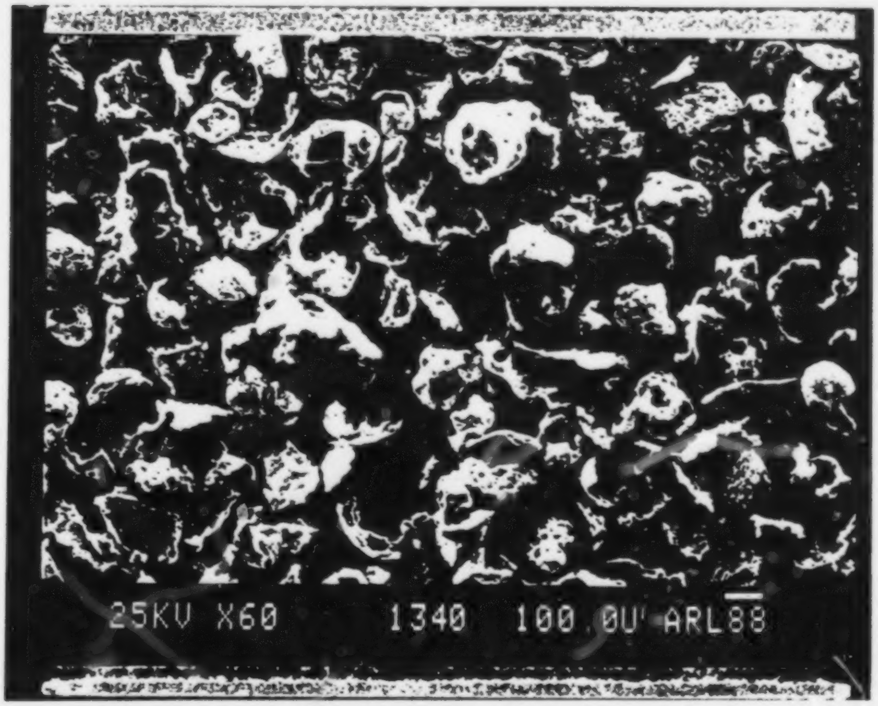
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Photo 6, SEM Micrograph of Stack # 2, > 106 μm Sample

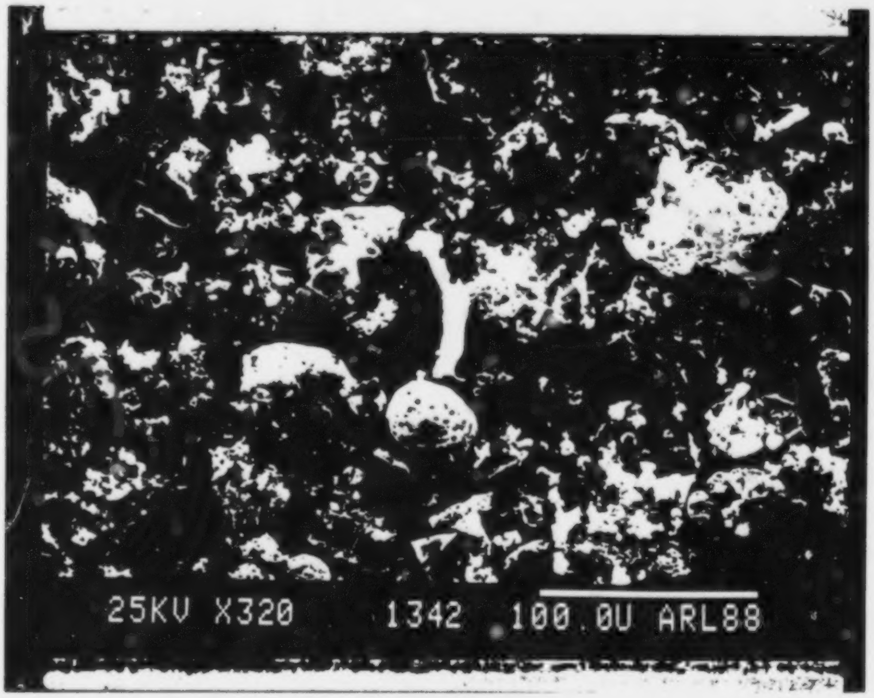
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Photo 7, SEM Micrograph of Stack # 3, < 45 μm Sample

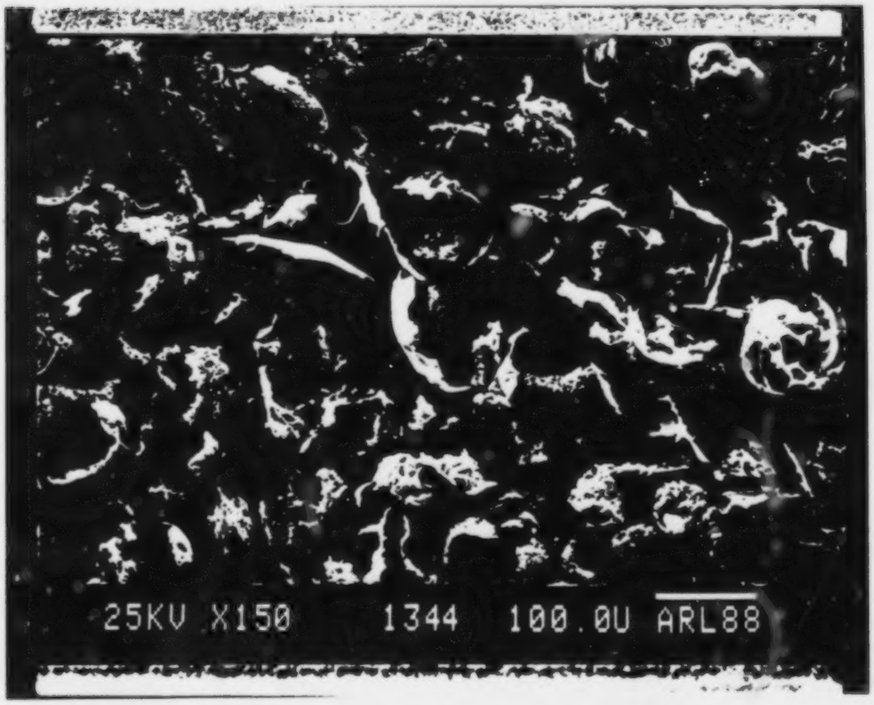
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Photo 8, SEM Micrograph of Stack # 3, 45 to 106 μm Sample

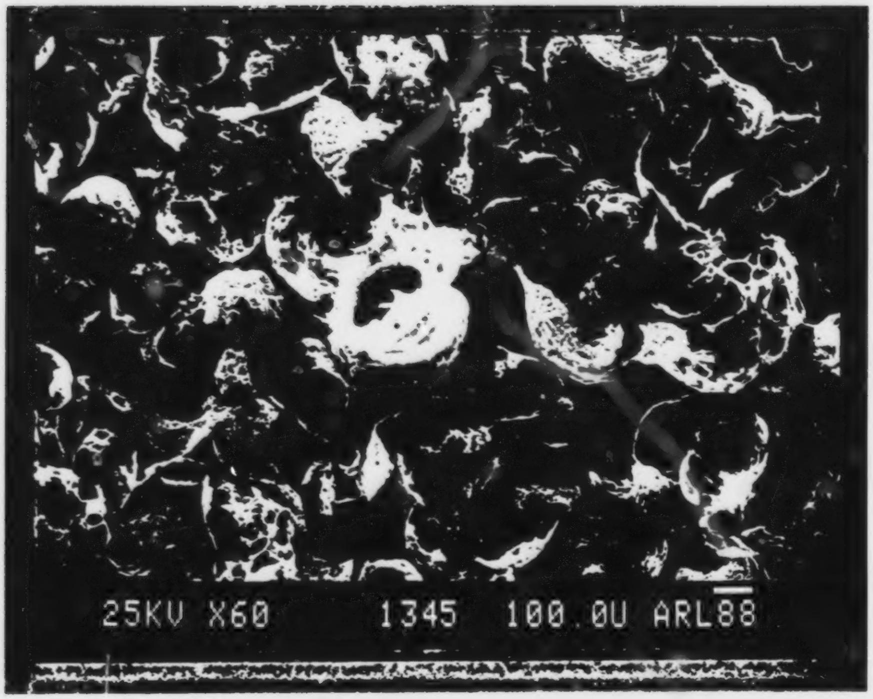
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Photo 9, SEM Micrograph of Stack # 3, > 106 μm Sample

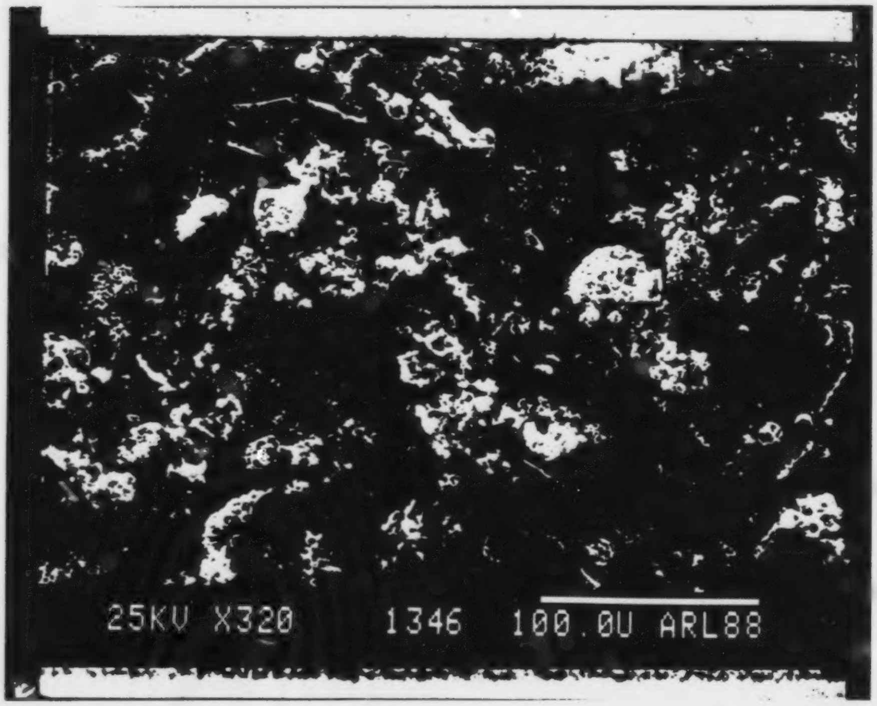
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Photo 10, SEM Micrograph of Stack # 4, < 45 μm Sample

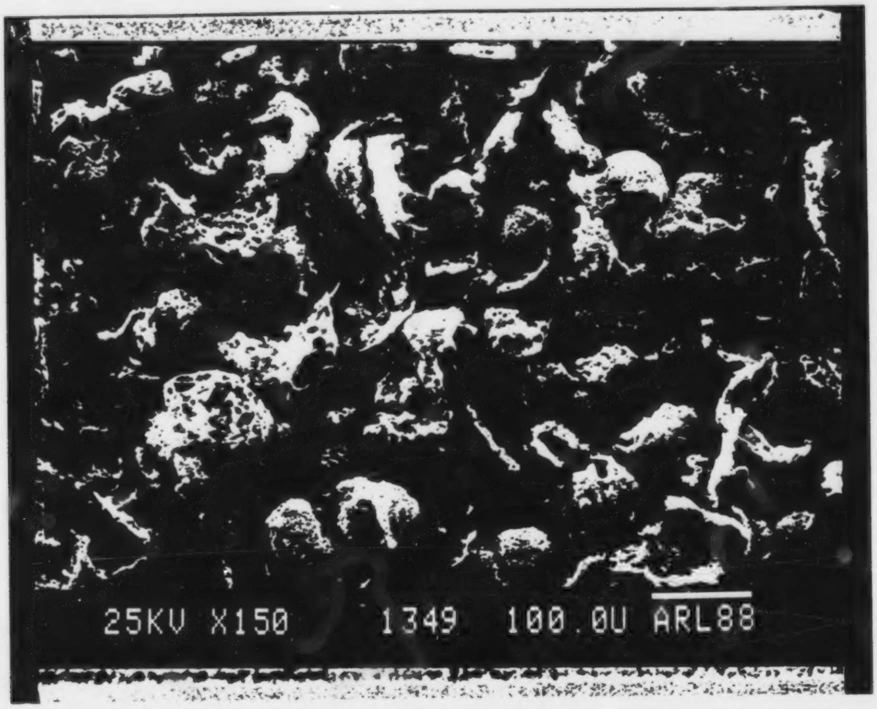
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Photo 11, SEM Micrograph of Stack # 4, 45 to 106 μm Sample

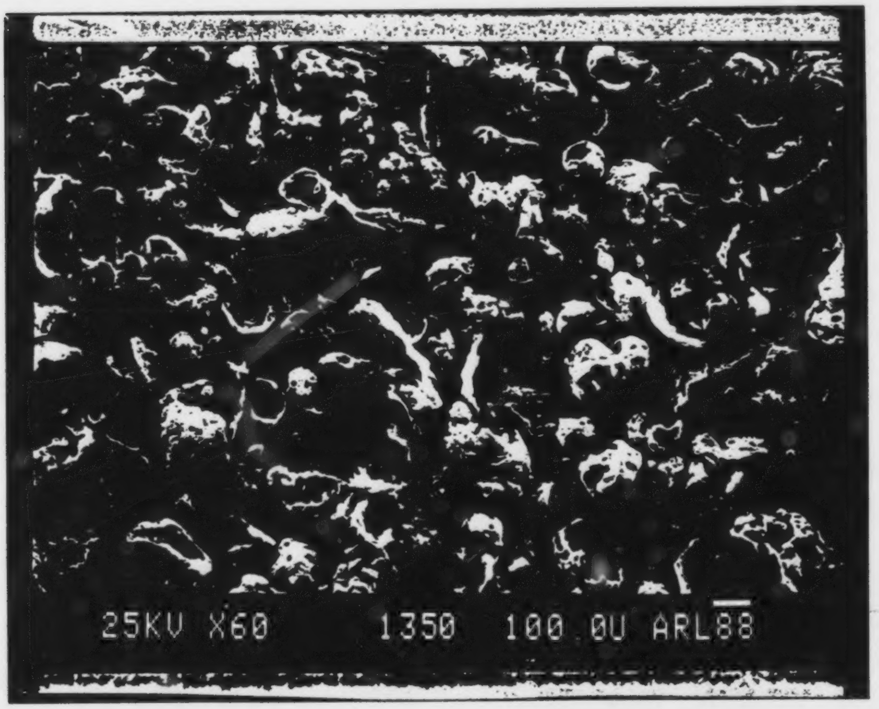
25KV X60 1350 100.0U ARL88

Photo 12, SEM Micrograph of Stack # 4, > 106 μm Sample

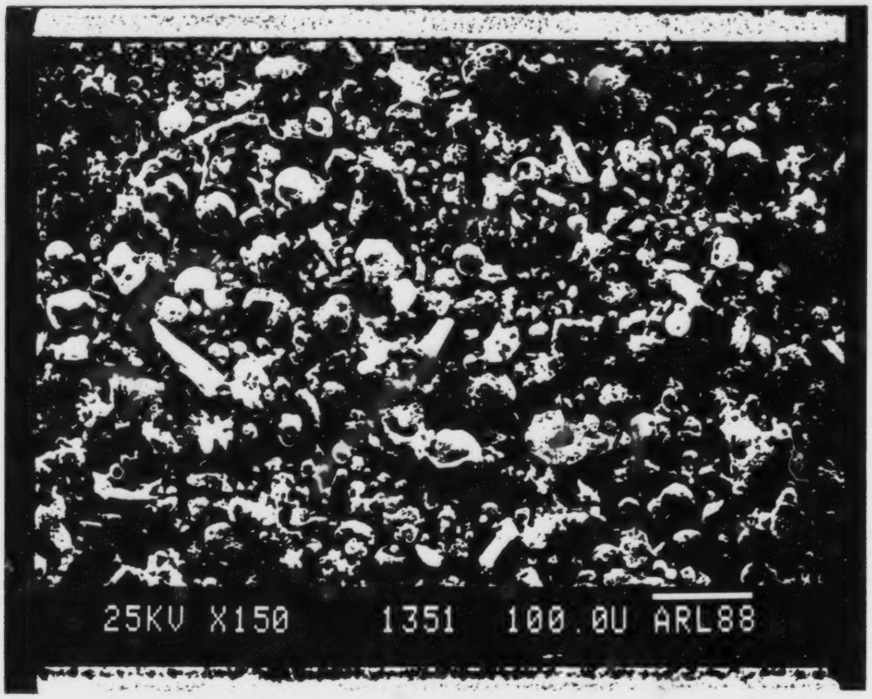
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Photo 13, SEM Micrograph of Hopper # 1, < 45 μm Sample

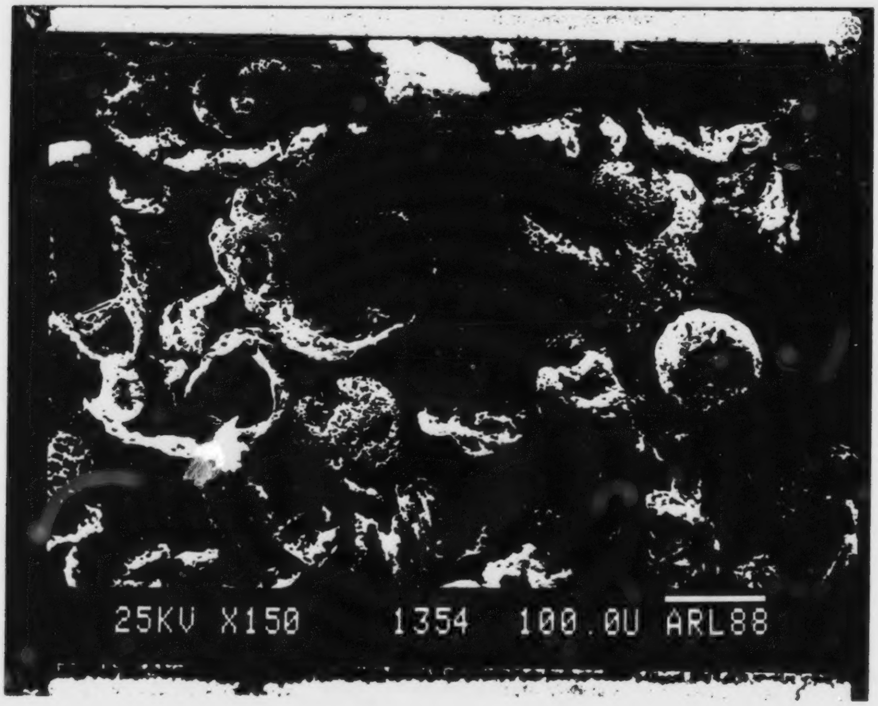
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Photo 14, SEM Micrograph of Hopper # 1, 45 to 106 μm Sample

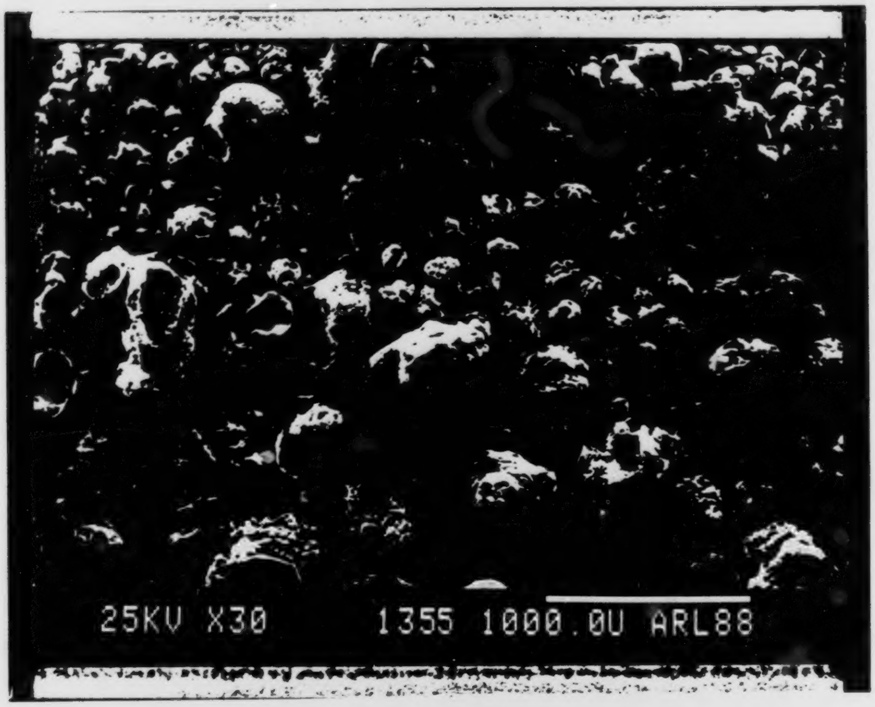
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Photo 15, SEM Micrograph of Hopper # 1, > 106 μm Sample

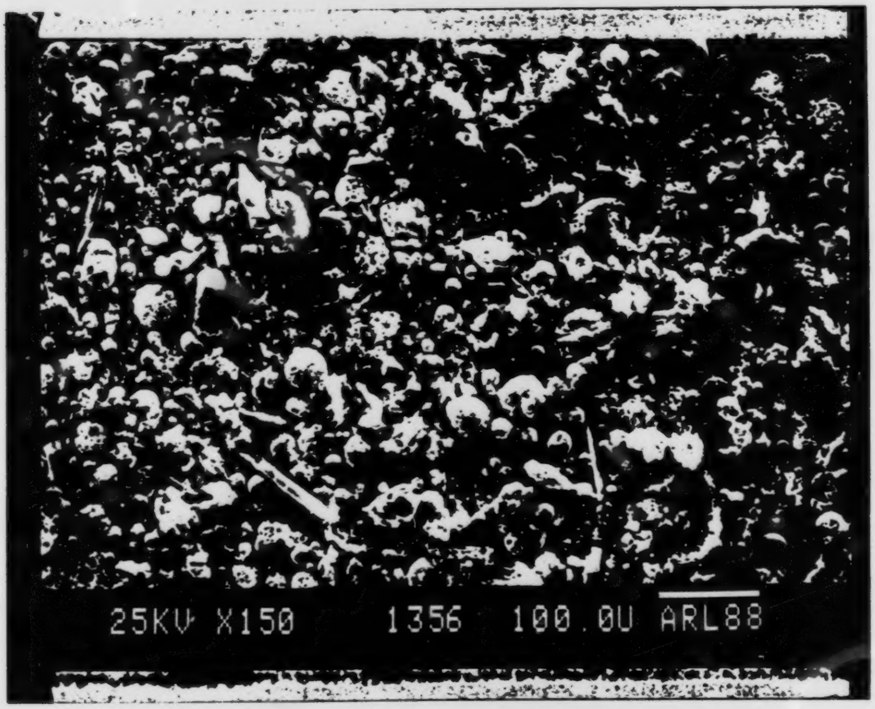
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Photo 16, SEM Micrograph of Hopper # 2, < 45 μm Sample

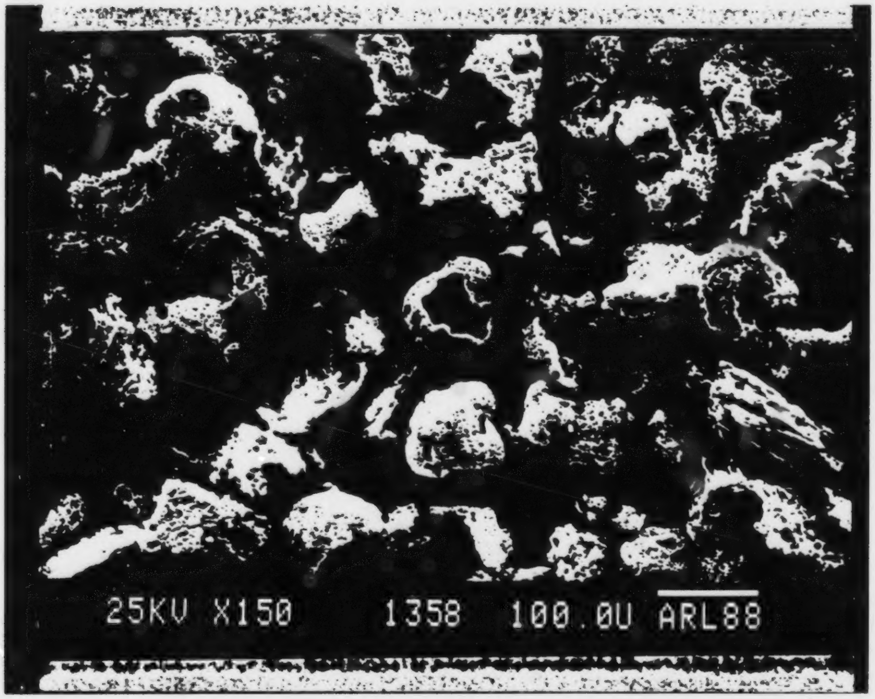
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Photo 17, SEM Micrograph of Hopper # 2, 45 to 106 μm Sample

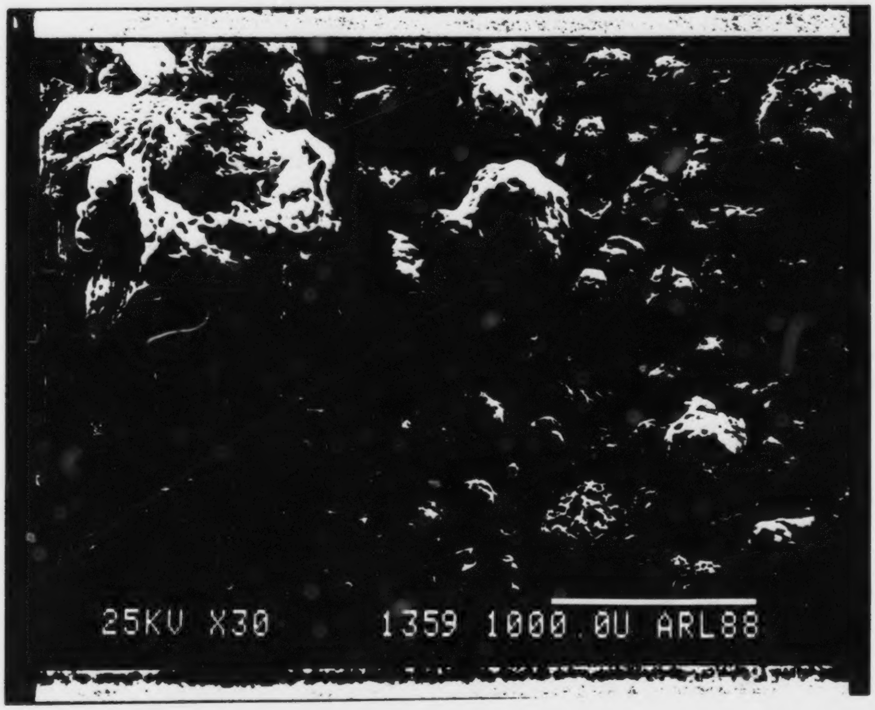
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Photo 18, SEM Micrograph of Hopper # 2, > 106 μm Sample

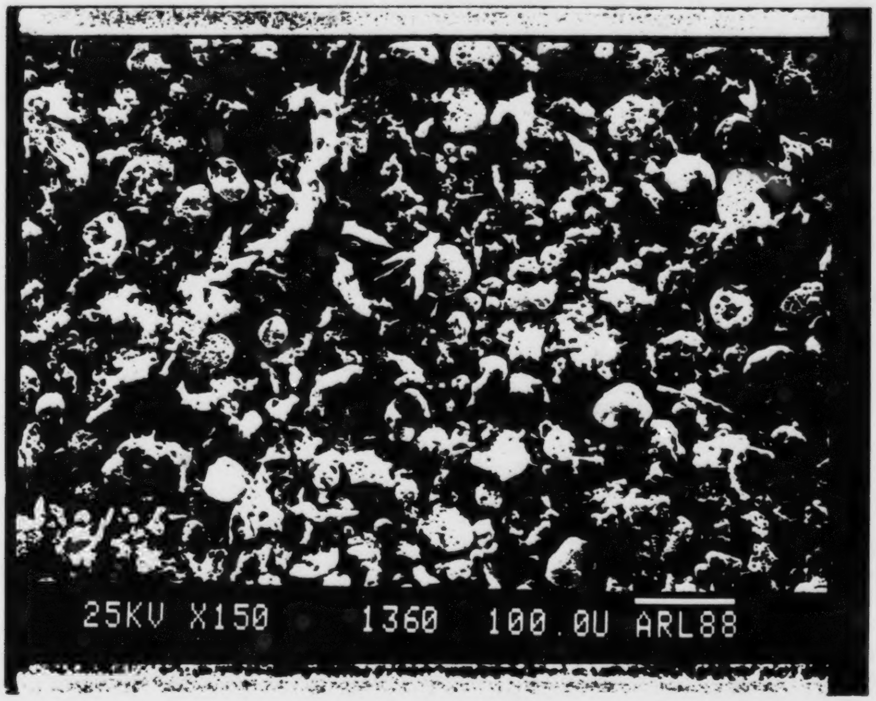
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Photo 19, SEM Micrograph of Hopper # 3, < 45 μm Sample

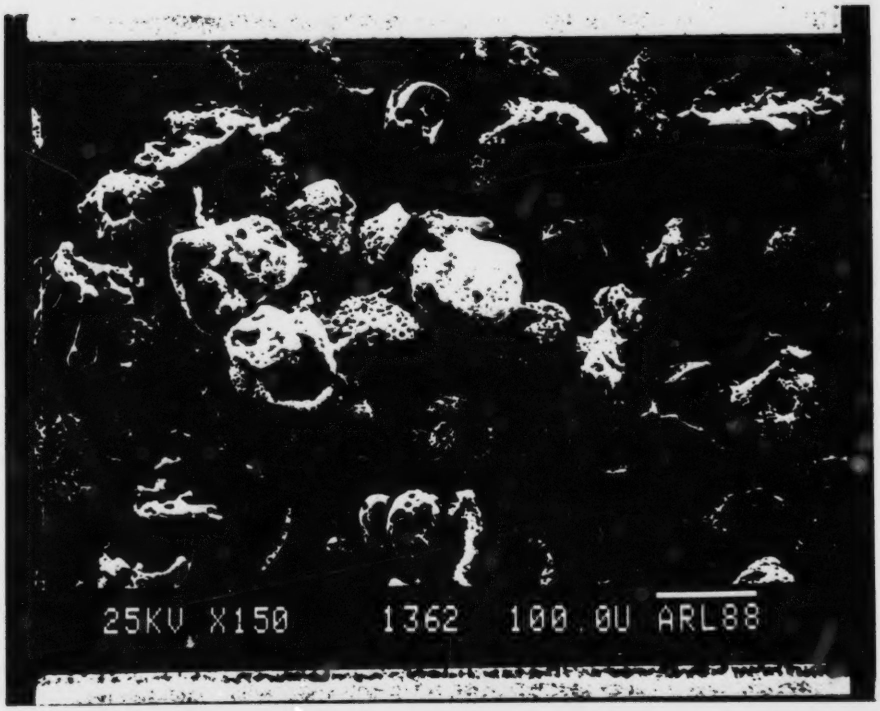
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Photo 20, SEM Micrograph of Hopper # 3, 45 to 106 μm Sample

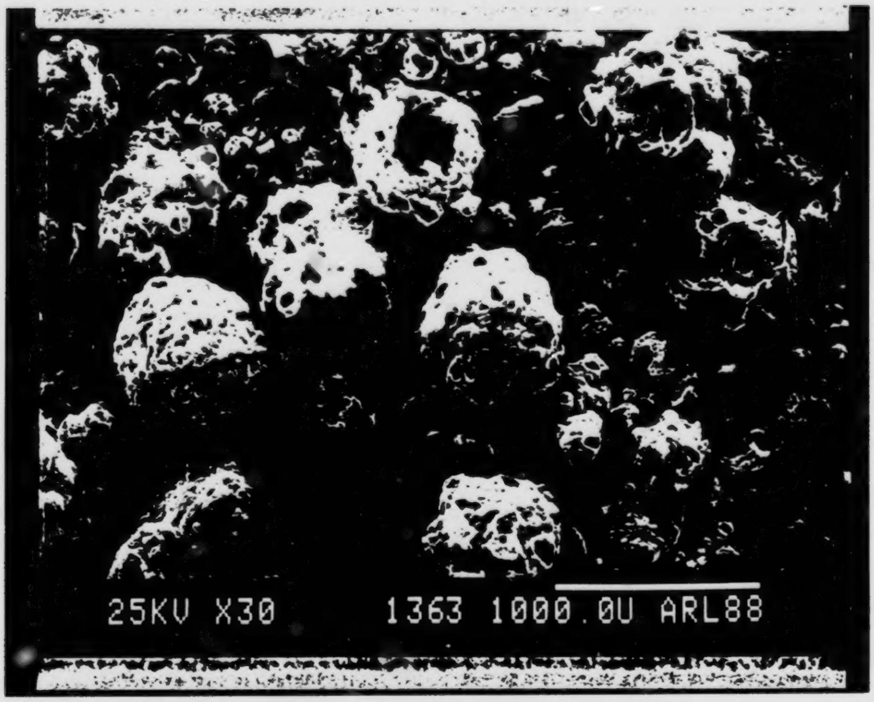
25KV X30 1363 1000.0U ARL88

Photo 21, SEM Micrograph of Hopper # 3, > 106 μm Sample

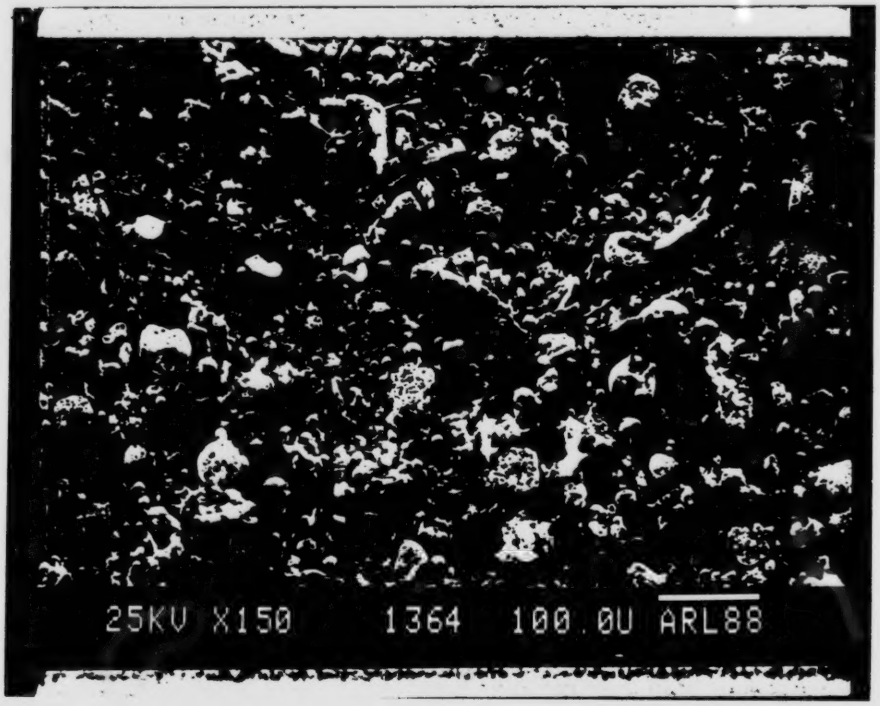
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Photo 22, SEM Micrograph of Hopper # 4, < 45 μm Sample

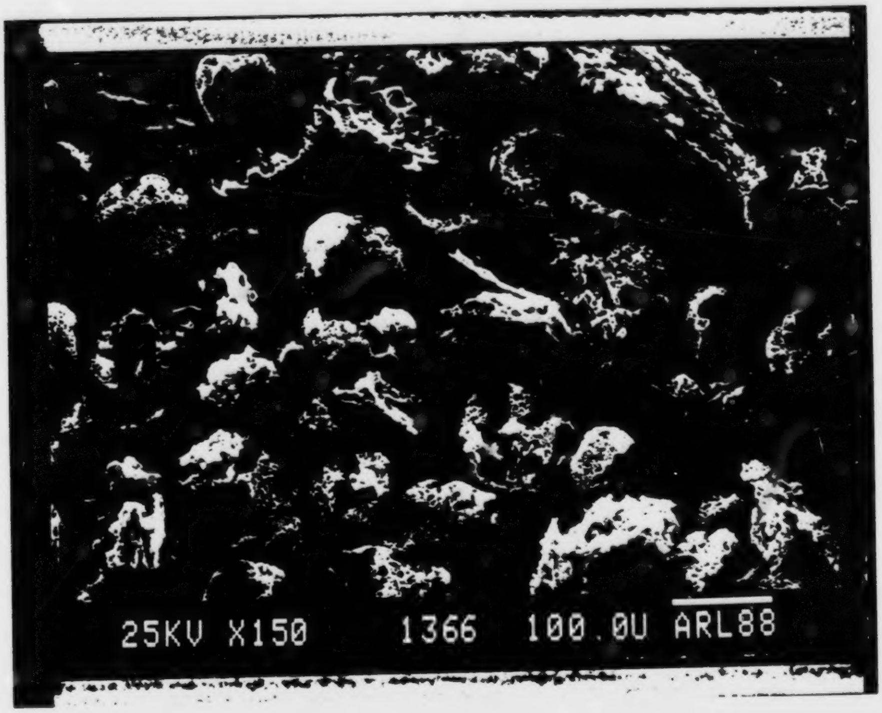
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Photo 23, SEM Micrograph of Hopper # 4, 45 to 106 μm Sample

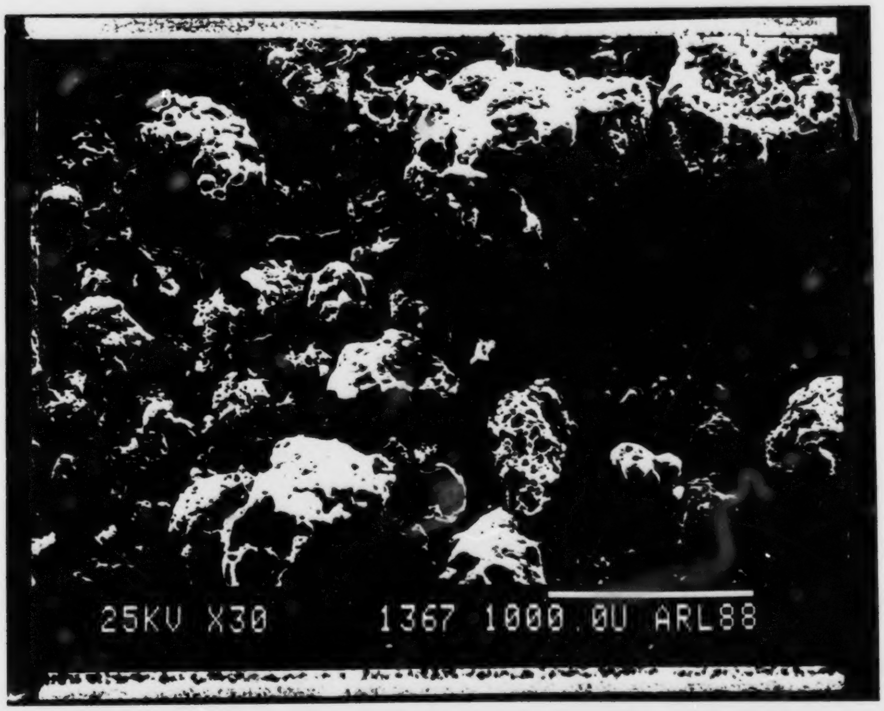
25KV X30 1367 1000.0U ARL88

Photo 24, SEM Micrograph of Hopper # 4, > 106 μm Sample

APPENDIX K

EMR-CANMET CWF FLYASH CHARACTERIZATION REPORT

THE MINAS BASIN COAL WATER FUEL DEMONSTRATION PROJECT: AN ASSESSMENT OF FLY ASH EMISSIONS AND DESIGN PARAMETERS FOR CYCLONE DUST COLLECTORS

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ABSTRACT

The particulate emissions from the Minas Basin Pulp and Power Co. CWF boiler were studied to evaluate the physical and chemical properties of the fly ash, and their influence on the design of cyclone collectors for particulate removal.

The fly ash emissions evaluated at two boiler loads and excess air levels were found to be mainly composed of large hollow cenospheres, partially broken, and fine shell fragments of porous cenospheric ash particles. The morphology of the ash particles was consistent with their origin from coarse spray droplets of aggregated coal fines that fuse and swell during coal devolatilization, and which subsequently fragment with increased char burnout and/or break-up of the coarse cenospheres during an induced rotation in the volatile burning phase. The ash properties showed that the carbon content increases with particle size, whereas the material and bulk densities decrease in the reverse order, in a manner consistent with the higher carbon content and porosity observed in the coarse hollow cenospheres. The proportion of coarse cenospheres in the boiler emissions was found to be influenced by the gas residence time, temperature and excess air available for char burnout in the boiler.

Theoretical calculations showed that the aerodynamic behaviour of the physically large hollow cenospheres and fine ash shell fragments was virtually identical due to large differences in their apparent densities. The char cenospheres and fine ash shell fragments were readily entrained in the gas flow and were removed in a multi-cyclone stack sampler with an effective cut-off aerodynamic diameter in the 5.5-6.3 µm range. The calculated aerodynamic fly ash size distributions were found to be in good agreement with these results, and showed that 50-80 % of the fly ash emissions from the boiler could be removed by high efficiency cyclones.

Based on these findings, the report presents an analysis of the impact of the fly ash properties on boiler and cyclone performance, and the influence of fuel, atomizer and boiler operating parameters on carbon burnout and the particulate collection efficiencies.

CONTENTS

Page

Abstract ii

1. Introduction 1

2. Ash Sampling and Operating Data 1

3. Fly Ash Characterization 2

3.1 Mechanism of CWF Combustion 2
3.2 Ash Morphology 2
3.3 Fly Ash Particle Size Distribution 3
3.3.1 Sieve Analysis 3
3.3.2 Coulter and Microtrac Analysis of Particle Size 4
3.3.3 Multi-Cyclone Analysis of Particle Size 5
3.4 Carbon in Ash 5
3.5 Ash Density 6

4. Estimation of the Fly Ash Aerodynamic Diameter 6

5. Design Parameters for Cyclone Dust Collectors 8

6. Practical Implications 9

Acknowledgements 10

Bibliography 11

Figures 12

Plates 20

1. INTRODUCTION

The Minas Basin Pulp and Power Company coal-water fuel demonstration project was commissioned in May, 1988. The project which was undertaken to demonstrate the technical and commercial viability of CWF as a replacement fuel for oil in small industrial boilers, is funded by the Cape Breton Development Corporation (CBDC), the Nova Scotia Department of Mines and Energy, Minas Basin Pulp and Power Company, and CANMET. The commercial viability of the project, based on a conversion from oil to coal firing without cost intensive boiler modifications, was hampered by a need to reduce a high concentration of particulate emissions. Consequently, the project participants initiated a study to identify the most cost effective ash collection system.

The first phase was aimed at stack sampling tests to ascertain the nature of the fly ash emissions, and to evaluate the impact of ash properties on the performance of cyclone dust collectors. Cyclones were specifically identified for ash collection due to their low capital and operating costs. This decision, in part, was also motivated by the experience in the Charlottetown CWF demonstration project where acid corrosion of fabric filters was a serious problem in an oil/CWF fired boiler.

Emissions testing and particulate characterization were undertaken by the Nova Scotia Research Foundation. The study was performed under the supervision of CBDC and the Energy Research Laboratories (ERL). This report presents an interpretation of the impact of the ash properties on boiler performance and cyclone design. The work undertaken by ERL is a cooperative contribution to the joint venture project.

2. ASH SAMPLING AND OPERATING DATA

Equipment and sampling procedures used in the boiler emission tests are described in a report by the Nova Scotia Research Foundation (1). The fly ash particulates were sampled in the ash collection hopper that removes coarse particulates before gas entry to the combustion air heater, and in the boiler stack. Isokinetic sampling procedures were followed in the boiler stack in order to obtain reliable measurements of the fly ash loadings and the aerodynamic diameter of the ash particles. In all other cases, ash sampling in the hopper and the boiler stack was aimed at collecting bulk samples that could be used to determine the physical and chemical properties of the fly ash.

The operating conditions during the ash sampling tests, conducted with a burner system with tertiary air entry via eight staging air ports (as modified by the author), are ? summarized in Table 1. Runs 1 and 2 at low and high excess air levels were obtained at a steam load corresponding to 50 % of the maximum boiler capacity, whereas runs 3 and 4 are more representative of the lower operating range of the boiler. These operating conditions are well within the 5.3-19.33 MW thermal input achieved on CWF from May to September, 1988. The operating range also corresponds to steam loads from 27-85% of the maximum boiler capacity.

TABLE 1. BOILER OPERATING CONDITIONS AND FLUE GAS LOADINGS

	CWF RATE (MW)	OXYGEN (%)	STACK TEMP (C)	FLY ASH (g/cu.m)
Run 1	10.5	3	159	3.66
Run 2	10.5	6	161	2.09
Run 3	7.7	?	143	3.37
Run 4	8.6	5	148	2.98

CWF ash (3.67 wt % dry)

For an input fuel ash concentration of 3.67 wt % on a dry basis, calculations show that fly ash loadings of 3.30, 2.95 and 2.8 gm^{-3} at 3, 5 and 6% oxygen respectively may be anticipated in the boiler stack. These estimates, as a rule, are expected to be lower than the fly ash loadings reported in Table 1, due to the presence of unburnt carbon in the fly ash. Any discrepancy in the calculated and measured values may be attributed to losses due to ash deposition in the boiler. The carbon in ash and fuel burnout efficiencies measured in the stack fly ash are described in section 3.4.

3. FLY ASH CHARACTERIZATION

This section describes results from the analytical work on the physical and chemical properties of fly ash particles obtained from the boiler emission tests. Most of the analytical work was performed by the the Nova Scotia Research Foundation. The Coulter and Microtrac particle size distributions of the fly ash were obtained by the ERL and CBDC. For an improved understanding of the fly ash morphology and properties, a brief review of the CWF combustion mechanism follows.

3.1 Mechanism of CWF Combustion

Figure 1 summarizes the combustion mechanism identified for a bituminous CWF (2). The fuel atomizer generates a spray composed of discrete coarse coal particles and droplets which retain the finer particles in the coal particle size distribution in the CWF (3,4). In the combustion zone, the coarse coal particles heat and devolatilize to form chars which are similar to those generated when the coal is burnt as a pulverized fuel. The surfaces of these char particles are highly porous with multiple blow holes (typically 1-10 µm in diameter) created by the escaping volatiles. With carbon burnout, the char particles form fly ashes which have a fused porous skeletal matrix. Due to lower temperatures experienced in a CWF flame, the fly ash particles are also less highly fused than their pulverized coal counterparts (5).

For the fuel droplets containing a number of fine coal particles, moisture evaporation and devolatilization initiates two distinct modes of combustion (3). In the first, char cenospheres with large internal cavities are formed when most of the volatiles escape through one or two big blow holes. The formation of two of more blow holes, on the other hand, initiates volatile combustion where the char aggregate spins and fragments due to high centrifugal forces. In both instances, shell fragments of ash particles are eventually formed in the advanced stages of carbon burnout. These fragmented ash cenospheres and the parent hollow char cenospheres are also highly porous due to a large concentration of surface micropores.

In the above description of CWF combustion, the tendency to form coarse hollow cenospheres and shell fragments during coal devolatilization increases with the swelling index of the coal. This behaviour is caused by the rapid melting and deformation of the coal particles at the outer surfaces of the dried multi-particle aggregates (Figure 1). Consequently, the tendency to form fly ashes with low apparent and bulk densities also increases with the swelling index of the coal. The CWF used is made from a bituminous coal having a high free swelling index (FSI of 5-7).

3.2 Ash Morphology

The fly ashes removed from the boiler were separated into three sieve fractions as summarized in Tables 2 and 3 (see section 3.3.1). The sieve fractions were then analyzed by scanning electron microscopy (SEM) to determine the morphology of the ash particles.

Plates 1 to 3 show SEM micrographs of the fly ash for run 4. In the coarsest sieve fraction (>106 µm), there is a high concentration of hollow cenospheres with large blow holes, and these particles also have a high unburnt carbon concentration (Table 4). The particle morphology is consistent with its origin from spray droplets which carry two or more coal particles. The largest of these were obviously formed from poorly atomized fuel droplets containing a high concentration of fine coal particles.

The ash particles in the 45 to 106 μm sieve fraction in Plate 2 appear to have undergone a greater degree of char burnout and fragmentation. The majority, which are hemispherical with large exposed cavities, are partially fragmented hollow cenospheres. A smaller concentration of finer rod-like shell fragments and intermediate-sized spherical particles probably represent hollow char cenospheres and coarse coal particles in advanced stages of carbon burnout.

The <45 μm particles in Plate 3 appear the most ash-like with the lowest unburnt carbon concentration (Table 4). A large number are fine shell fragments with a high concentration of surface micropores. A number of fine spherical particles, which are mainly pure iron oxides, are also evident. These originate from the fine iron pyrites that are difficult to remove during coal cleaning. When they convert to oxides in the flame, the iron pyrites liberate sulphur oxides.

3.3 Fly Ash Particle Size Distribution

3.3.1 Sieve Analysis

Bulk fly ash samples removed from the hopper and boiler stack were separated into three sieve fractions. The particle size distributions (PSD) by mass in these sieve fractions are shown in Tables 2 and 3. For the hopper fly ashes, which were removed by inertial separation from the flue gas entering the air heater, the PSD are significantly coarser than those measured for the entrained stack fly ash. From the previous description of the morphology of the ash particles (section 3.2), it is apparent that the hopper ash has a higher concentration of large unburnt hollow cenospheres. For the stack fly ash samples, the sieve analyses indicate a higher concentration of broken cenospheres and finer shell fragments.

TABLE 2 SIEVE ANALYSIS OF HOPPER FLY ASH

Size (um)	Run 1	Run 2	Run 3	Run 4
< 45	28.9 %	46.9 %	18.6 %	34.7 %
45 -106	31.6 %	40.5 %	23.5 %	33.2 %
> 106	39.5 %	12.6 %	57.9 %	32.1 %

TABLE 3 SIEVE ANALYSIS OF STACK FLY ASH

Size (um)	Run 1	Run 2	Run 3	Run 4
< 45	75.8 %	81.2 %	77.1 %	72.6 %
45 -106	20.6 %	16.1 %	19.2 %	21.7 %
> 106	3.70 %	2.80 %	3.80 %	5.60 %

Due to the possibility of attrition damage of the coarse unburnt cenospheres during particle sieving (see section 3.3.2), there are inherent errors in the data in Tables 2 and 3. Lower and higher mass fractions of the finer and coarser sieve fractions respectively may be anticipated in the ash particulates entrained in the flue gas. During normal boiler operation, the ash particles dropped in the air heater hopper are eventually re-entrained into the gas flow. It is expected that these coarse cenospheres will decrease with increased carbon burnout and fragmentation as they pass through the air heater and induced draft fan. Thus, the sieve analyses of hopper and stack fly ashes show that there is a fairly high concentration of entrained unburnt char cenospheres in the gas flow leaving the furnace and convective heat transfer sections of the boiler.

3.3.2 Coulter and Microtrac Analyses of Particle Size

The PSD of the stack fly ash, which is of most interest to the design of the cyclone collectors, was analyzed using three different procedures. Ash particles <45 μm were analyzed by a Coulter counter equipped with a 280 μm aperture tube. The PSD was then combined with the mass fractions of the material retained on the 45 and 106 μm sieves (Table 2). In the second and third methods, the PSD of the stack fly ash was determined without further treatment in a Microtrac analyzer and a Coulter counter equipped with three different aperture tubes. The multiple aperture tubes permit a more accurate analysis of the larger and smaller ash particles.

Figures 2 to 5 compare the PSD determined by the three methods. The coarsest fly ash PSD was measured by the Microtrac analyzer. The data also indicate a poor sensitivity to any variations in the ash particle size between different boiler tests. This feature suggests inherent errors in the ash PSD measured by the Microtrac analyzer. These errors may have been caused by the poor wetting and dispersion of fine fly ash particles. A comparison with the three-tube Coulter data confirms this trend. The Coulter data show a three peak PSD which roughly corresponds to the different types of ash particles, i.e., fine shell fragments, partially broken and unfragmented coarse cenospheres identified in the SEM evaluation (section 3.2). The Coulter-sieve data with a two peak distribution show a finer PSD compared to the Microtrac analyzer; an apparent improvement due to the initial sieve separation of coarse particles. However, compared with the three-tube Coulter data, a very poor resolution of the finer fly ash fraction occurs. A higher concentration of particles in the 10-20 μm size range relative to the Coulter data also shows that some of the particles in this range may have originated from attrition of the coarse fly ash cenospheres during particle sieving. Thus, because of the possibility of errors due to particle attrition and poor dispersion of fine particles, the three-tube Coulter data are assumed to be the most reliable.

The Coulter counter measures the displaced volume of the ash particles. The size distribution data therefore represent estimates of the volume-equivalent spherical diameter (d_e; section 4). The PSD determined by the Coulter counter, which measures the displaced volume of particles of uniform mass, is unable to detect the void volume of the randomly dispersed surface micropores (6). This feature, which stems from poor wetting and liquid penetration of the micropores, will yield measured spherical diameters that are coarser than the true volume-equivalent diameter of the solid phase in the ash particles. However, these errors are not expected to be large. The inherent errors also exclude the large internal cavities found in the hollow ash cenospheres, since these cavities with large surface blow holes are readily filled by the suspending electrolyte during particle size analysis.

Figures 6 to 9 show the Coulter volume weighted, cumulative and differential particle size distributions of the stack fly ash. A comparison with the PSD of the coal in the CWF (Figure 6) shows an appreciable swelling of the coal particles during fuel combustion, as characterized by a shift in the fly ash (differential) size distribution curve towards the coarser size fractions above 50 μm. Below 50 μm, the fly ash particles are finer than the parent coal due to fragmentation of the hollow ash cenospheres during CWF combustion. When comparing data for the different tests, the fly ash becomes finer with increasing excess air, due to increased carbon burnout (see section 3.4) and fragmentation of the coarse fly ash cenospheres. This effect is clearly shown by the absence of a high concentration of ash particles larger than 100 μm noted for the fly ash emissions in run 2 (compare Figures 6 and 7). The same trends were also found in the sieve analysis of the ash (Table 3), where significantly lower concentrations of coarse and partially fragmented cenospheres were measured as the excess air increases at a constant boiler load. A coarser PSD for the fly ash is noted as the boiler load decreases at high excess air (Figures 7, 8 and 9). A finer fly ash PSD from increased burnout and fragmentation may be expected as the char residence time in the boiler increases at lower firing rates, but it appears that the reduced gas temperature (at low loads) has a more pronounced negative impact on char burnout. The latter effect is also supported by the higher stack fly ash loadings measured at low loads (Table 1).

3.3.3 Multi-Cyclone Analysis of Particle Size

The PSD of the stack fly ash determined from in-situ measurements with a multi-cyclone stack sampler are shown in Figures 10 to 13. In this method, the fly ash fractions collected in four stages of cyclones and a back-up filter are reported in terms of an average (50%) aerodynamic diameter, $d_{a,\eta}$ (see section 5). Because these particle diameters also represent the mean aerodynamic resistance due to particle slip, i.e., the combined influence of particle density and size effects (see section 4), the measured PSD is significantly finer than the physical dimensions reported in sections 3.3.1 and 3.3.2.

The aerodynamic PSD of the stack fly ash in Figures 10 to 13 show that 50-80 % of the ash particles fall in a size category > 5.5 - 6.3 μm. When these results are compared with the sieve analysis shown in Table 3, it is apparent that the bulk of the broken cenospheres and shell fragments, although large physically, are extremely light; the ash particles are readily entrained in the gas flow through the boiler (see also sections 4 and 6).

3.4 Carbon in Ash

Figures 14 to 17 and Table 4 report the carbon in ash values measured for the different sieve fractions of the stack fly ash (Table 3). The carbon in ash values generally decrease with the ash particle size, being highest for the hollow cenospheres and lowest for the shell fragments. The carbon in ash also decreases with increasing excess air at a given boiler load, and increases with a decreasing boiler load, the latter from a higher concentration of unburnt carbon in the unfragmented and partially fragmented hollow ash cenospheres.

The carbon in ash values may be expressed in terms of a fuel burnout efficiency using the following relationship derived for low-ash coal-water fuels (7);

$$C_x = [\,1 - (A_o/A)]/(\,1 - A_o) \qquad (1)$$

where C_x is the fractional fuel burnout efficiency, A_o is the ash fraction in the dry coal, and A is the ash fraction (or 1 - A the carbon fraction) in the fly ash. Table 4 also shows the calculated fuel burnout efficiencies on a sieve fraction basis. The overall fuel burnout efficiencies for the respective boiler runs shown in Table 4 were calculated from the mean carbon in ash values that were also measured for the unsieved ash samples.

TABLE 4 CARBON AND FUEL BURNOUT IN STACK FLY ASH

Sieve (um)	Run 1		Run 2		Run 3		Run 4	
	1 - A	Cx	1 - A	Cx	1 - A	Cx	1 - A	Cx
< 45	0.31	0.98	0.30	0.98	0.35	0.98	0.38	0.98
45-106	0.63	0.94	0.41	0.97	0.58	0.95	0.54	0.96
> 106	0.81	0.84	0.79	0.86	0.84	0.80	0.85	0.78
Unsieved Ash	0.45	0.97	0.32	0.98	0.46	0.97	0.51	0.96

Table 4 shows that the fuel burnout efficiencies are poor for the unfragmented and partially fragmented hollow cenospheres. However, overall fuel burnout efficiencies at 97, 98, 97 and 96% for runs 1 to 4 respectively are high, due to a large concentration of shell fragments with a low carbon content found in the stack fly ash (Table 3). For further improvements in the fuel conversion efficiencies, measures must be adopted to minimize the concentration of the coarse char cenospheres that originate from the large fuel droplets (section 3.1).

3.5 Ash Density

Figures 14 to 17 also show the measured skeletal and bulk densities of the stack fly ash. The skeletal densities measured by a helium pycnometer excludes the void volume of the surface micropores and empty cavities within the ash particles. The skeletal density therefore represents the material density, ρ_p, of the ash particles. The bulk densities on the other hand include the void volume of micropores, internal and interstitial particle cavities, and the measured values are significantly lower than the skeletal or material density. Equations (11) and (12) define the functional dependence between the material (ρ_p), apparent (ρ_a) and bulk (ρ_b) densities of the ash particles.

The material densities in Figures 14 to 17 increase with a decreasing carbon content in the finer fly ash fractions. The measured data also approach the 2500 to 2700 kg m^{-3} range expected for ash particles with no carbon. Due to the morphology which results in an increasing void volume in particles with large internal cavities (as opposed to those with micropores in the finer ash fraction), the bulk density also decreases for the coarser fly ash fractions.

4. ESTIMATION OF THE FLY ASH AERODYNAMIC DIAMETER

Fly ash particles participate in inertial processes, i.e., gravitational settling, impaction on heat transfer tubes and collection in cyclones due to their aerodynamic resistance to the convecting gas flow. This resistance results in particle slip relative to the convecting gas. For fine particles (such as those examined in this report) the aerodynamic resistance and particle slip arises from viscous drag. Thus, the mean aerodynamic behaviour in inertial processes may be modelled by the gravitational settling velocity of the ash particles in the Stokes flow regime (when the particle Reynolds number, Re < 1).

For a spherical particle of homogeneous mass at Re < 1, the terminal settling velocity, U_{st}, is given by;

$$(\pi/6)\, d_{st}^3\, g\, (\rho_p - \rho) = 3\pi\, d_{st}\, \mu\, U_{st} \qquad (2)$$

where the term $3\pi\, d_{st}\, \mu\, U_{st}$ is the viscous resistance to particle slip, ρ_p the material density, ρ the gas density, μ the gas viscosity and d_{st} the particle diameter. From Equation (2);

$$U_{st} = g\, (\rho_p - \rho)\, d_{st}^2 \,/\, 18\, \mu \qquad (3)$$

For irregular particles which can fall in any randomly selected orientation the equivalent result is formulated in terms of a mean viscous resistance $c\, \mu\, U_{st}$;

$$U_{st} = g\, (\rho_p - \rho)\, \pi\, d_e^3 / (6\, c\, \mu) \qquad (4)$$

where d_e is the volume-equivalent diameter of the particle, and c is the mean resistance taken over all possible orthogonal particle orientations. Equating the values of U_{st} in Equations (3) and (4) gives;

$$d_{st} = (3\, \pi\, d_e^3 \,/\, c)^{0.5} \qquad (5)$$

and provides a method of estimating the Stokes diameter of an irregular particle from the measured volume-equivalent diameter, de. Also, d_{st} may be interpreted as the equivalent viscous resistance diameter of the fly ash particles. However, as it is conventional to evaluate the mean resistance of the fly ash particles in terms of an aerodynamic diameter whose settling velocity is the same as a sphere of density $\rho_o = 1000$ kg/m^3, Equations (3) and (5) give;

$$d_a \equiv [(\rho_p / \rho_o)(3 \pi d_e^3 / c)]^{0.5} \tag{6}$$

for $\rho << \rho_p, \rho_o$, and d_a is the equivalent aerodynamic diameter of the fly ash particles. In order to estimate the aerodynamic diameter from the measured volume-equivalent diameter of the fly ash particles (section 3.3.2), it is necessary to calculate the mean resistance c.

The mean resistance may be calculated for the irregular fly ash particles by making certain assumptions for the particle shape. For oblate spheroids (Figure 18) with an equatorial diameter, a, larger than the polar diameter, b, the mean resistance is defined by (8);

$$c = 3 \pi a (1 - E^2)^{0.5} / \mathrm{Cos}^{-1} E \tag{7}$$

whereas for prolate spheroids (Figure 18) the corresponding expression is (8);

$$c = 3 \pi a (E^2 - 1)^{0.5} / \ln [E + (E^2 - 1)^{0.5}] \tag{8}$$

where E is the particle aspect ratio b/a. The aspect ratio may also be expressed in terms of the volume-equivalent diameter, d_e;

$$E = (d_e / a)^3 \tag{9}$$

The fly ash morphology (section 3.2) has shown that particles in the sieve fraction >106 μm are hollow cenospheres which are mainly spherical (E = 1), while others formed from the fusion of a number of coal particles in very coarse spray droplets (section 3.2) resemble prolate spheroids with E = 2. For the sieve fraction <45 μm, the fragmented cenospheres with more complete combustion represent flakes (E = 0.05) and lenticular shapes (E = 0.5). For coal particles separated and burnt as single entities during atomization, and for liberated ash pyrites converted to ferrous oxide particles on heating, the fly ash particles are mainly spherical. The measured mean bulk and material densities (section 3.5) indicate that the majority of the particles in these two sieve fractions are highly porous, due to large internal cavities and micropores present on the particle surfaces. Thus, the particles are not homogeneous, and it is necessary to use an apparent density for these assumed particle shapes when calculating d_a from Equation (6). The apparent density is defined by;

$$\rho_a = \rho_p (1 - \varepsilon_a) \tag{10}$$

where ε_a is the voidage of the large internal cavities and surface micropores on the ash particles. Defining an interstitial voidage ε for the fly ash samples subjected to the bulk density measurements, we have the following relationship between the bulk and apparent densities;

$$\rho_b = \rho_a (1 - \varepsilon) \tag{11}$$

Since no attempt was made to measure ρ_a as a parameter distinct from the bulk and material densities, it is necessary to assume values for ρ_a. A recent publication (9) has reported measured values of the apparent densities for material similar to the hollow cenospheres found in the >106 μm fly ash sieve fraction. The apparent densities were typically in the 400 to 800 kg/m^3 range, with the lower values measured for cenospheres with large internal cavities and higher values for those with surface micropores. The data reported in Figures 14 to 17 show bulk densities from 180 to 539 kg/m^3 for the fly ash, and it would be reasonable to use these values as an approximate measure of the apparent fly ash density in Equation (6). The errors introduced by this assumption will result in smaller calculated values of the aerodynamic diameter for the hollow and fragmented fly ash cenospheres. These errors are proportional to $(\rho_a/\rho_b)^{0.5}$.

It should also be noted that the Coulter measurements of the fly ash diameter (d_e) are overestimated due to poor penetration of the suspending electrolyte into the small surface micropores of the ash particles (section 3.3.2). This error, which predicts larger values of d_a for both the hollow and fragmented cenospheres, is directly proportional to the ratio of the true and measured volume-equivalent diameters. Taken together, the smaller aerodynamic size predicted by the bulk density may compensate for the coarser aerodynamic distribution predicted by errors in the measured volume-equivalent diameter of the fly ash particles.

Figures 19 to 22 show the aerodynamic diameters calculated using the above method. In developing curves for the aerodynamic size distribution from the Coulter volume diameter data, it was assumed that the fly ashes were represented entirely by hollow (prolate) cenospheres with aspect ratios E = 1, 2 and fragmented (oblate) cenospheres with aspect ratios E = 0.05, 0.5, 1. The hollow and fragmented cenospheres were modeled because they represent two extremes of the fly ash particle morphology, and properties such as density, size and carbon content found in the boiler fly ash emissions (section 3).

The calculated aerodynamic diameters in Figures 19 to 22 are significantly finer than the physically measured particle diameters. Due to increasing viscous drag and hence lower settling velocities of the fly ash particles, the aerodynamic diameter decreases when the particle aspect ratio increases or decreases from the value for a perfect sphere (E = 1). The aerodynamic diameters calculated for the hollow cenospheres are also finer than those estimated for the fragmented cenospheres, despite the larger physical dimensions of the former particle type. This trend may be explained by the higher carbon content and large internal cavities found in the hollow cenospheres, which significantly reduce the apparent densities relative to the values measured for the fragmented cenospheres (see above and section 3.5). From these findings, it would appear that the smallest shell fragments (E = 0.05) and the largest hollow unburnt cenospheres (E = 2) entrain readily in the gas flow, and represent fly ash particles in the boiler emissions which are very difficult to remove in an inertial dust collection device.

5. DESIGN PARAMETERS FOR CYCLONE COLLECTORS

Cyclones are generally considered to be effective collection devices for dust particles larger than 5 μm (10). For a fine dust collection duty, design parameters dictate a number of small parallel or series multi-cyclone units for the effective separation without re-entrainment of the dust particles. In cyclone design, attention is most often focused on a critical dust collection zone below the gas exit tube, where the swirl velocities are high. For dust particle collection in this zone, the centrifugal force imparted on a particle travelling at a gas swirl velocity, V_θ, must overcome an inward drag force due to a radial gas velocity, V_r. When these forces balance, the dust has an equal chance of being captured or re-entrained. For fine spherical particles of uniform density Stokes drag (Re < 1) is usually assumed, and a force balance yields;

$$(\pi d^3/6)\, \rho_p\, (V_\theta^2 / r) = 3 \pi \mu d V_r / F \qquad (12)$$

where F is the Stokes-Cunnigham 'slip correction factor' (11), and d and ρ_p as defined previously are the particle diameter and density respectively. From Equation 10;

$$[(F \rho_p d^2 V_\theta) / (18 \mu r)] = (V_\theta / V_r) \qquad (13)$$

where the left hand term is the Stokes number, St, or the inertial collection parameter. In the above equation, it can be seen that the right hand term is a parameter specific to a particular cyclone design configuration. In most cases, the design efficiency is expressed in terms of the Stokes number as shown schematically in Figure 23(a). With appropriate corrections for the mean resistance of non-spherical particles, the expressions for d in terms of the aerodynamic diameter, d_a, and V_θ and V_r in terms of the cyclone inlet velocity, V_i, and the barrel diameter, D, the Stokes number may also be expressed as;

$$St = [(F \rho_o d_a^2 V_i)/(9 \mu D)] \qquad (14)$$

where $\rho_o = 1000\ kg/m^3$. Cyclone performance can also be defined in terms of a cut of aerodynamic diameter $d_{a,\eta}$ (Figure 23. b), for which $\eta = 50\%$ or 80% of the dust particles are collected. For a specified performance, the pressure drop, which is assumed to be dominated by form drag at high gas Reynolds number, is usually expressed as;

$$\Delta P = \xi (\rho V_i^2/2) \qquad (15)$$

where ξ is the number of inlet velocity heads. The pressure drop is also dependent on the collection efficiency and dust loadings (10).

When sizing cyclone collectors, the inlet size distribution of the fly ash must be specified. The selected distribution must also represent the finest particulate to be collected by the device. In section 4, it was shown that the hollow cenospheres with an aspect ratio E = 2 represent the finest dust dispersion in terms of its aerodynamic diameter. These dispersions are also marginally finer than the shell fragments with E = 0.05, which represent the other extreme in the type of ash particles found in the boiler emissions. Figure 24 shows the aerodynamic diameter of these hollow cenospheres estimated for the four boiler tests. The curves show that run 2 generates the lightest particulate emission. For comparison, the aerodynamic distribution of the fly ash emissions measured by the multi-cyclone stack sampler (section 3.3.3) are also shown in the Figure. The measured data compare favourably with the calculated aerodynamic particle size distributions. Taking the calculated distribution for run 2 as an example, it can be seen that the average (50%) aerodynamic diameter of the fly ash is 6 μm. Figure 11 shows that 57% of the fly ash particles for this run were removed in the multi-cyclone with a cut off diameter > 5.5 μm.

For design purposes, it would be appropriate to size the cyclone collectors based on the results shown for run 2 in Figure 24. The operating conditions corresponding to these curves indicate a boiler load of 10.5 MW and high excess air. Significant deterioration in the cyclone performance is not expected at lower boiler loads and reduced excess air levels, because the results in Figure 24 show that the aerodynamic distribution of the fly ash particles becomes coarser for these operating conditions. However, it is more difficult to predict cyclone performance at CWF firing rates above the 10.5 MW load reported in Figure 24 (runs 1 and 2). If one may speculate, the atomizer performance may be justifiably expected to deteriorate at higher fuel throughputs, producing a greater concentration of slurry droplets with multiple coal particles that form hollow char cenospheres. At higher gas velocities (increased entrainment) and reduced residence times for char burnout within the boiler, it is likely that the concentrations and loadings of these aerodynamicaly fine hollow cenospheres will increase. In this instance, the cyclone performance will deteriorate if the aerodynamic particle size distribution becomes smaller than the data reported for run 2 in Figure 24.

6. PRACTICAL IMPLICATIONS

The preceding analysis of the properties of fly ash emissions from the Minas boiler has a significant impact on the boiler performance, and the application of cyclone collectors to clean the stack emissions.

Due largely to the mechanism of combustion of the high free swelling index coal, highly porous char and ash particles with low apparent densities are formed in the flame envelope. The subsequent reaction of unburnt char outside the flame envelope is determined by the gas temperature, excess air and the particle residence time in the boiler. Unlike pulverized coal chars which have high inertial slip velocities by virtue of their size and high apparent densities, the aerodynamicaly light char cenospheres from CWF combustion have negligible slip and are readily entrained by the gas flow through the boiler. Thus, the lower gas as opposed to the particle residence time determines the degree of carbon burnout in the CWF fly ash. The analysis in section 4 has shown that the high carbon coarse hollow cenospheres and the high ash fine shell fragments are equally light; the fuel burnout efficiency in the boiler is essentially determined by the concentration, degree of fragmentation and burnout of the hollow char cenospheres.

Depending on the competing effects of a decreasing gas residence time that reduces char burnout, and increasing gas temperatures and excess air that increases char burnout, there is an optimum firing range for the boiler where the fuel conversion efficiency and the boiler heat absorption is highest. At boiler loads above and below this range poor fuel burnout and a high concentation of particulate emissions will have a negative impact on the boiler performance. The improved combustion efficiencies noted as the excess air increases at 10.5 MW (Tables 1 and 4) show that the optimum firing range will occur at a boiler load somewhat higher than this value. From basic differences in the volumes of oil and coal-designed boilers (lower for an oil design), and the fact that the gas volumes required for coal combustion are substantially higher, it is apparent that the optimum firing range for CWF (from gas residence time considerations) in the Minas boiler will be substantially lower than the maximum rated boiler capacity. This optimum range for CWF needs to be established from further tests.

In view of the dominant influence of the ash morphology and entrainment processes, very little improvement in the boiler performance is possible by modification of the burner design. The design parameters for the burner register with the eight tertiary staging air ports were established to maximize the flame turn-down stability, and to minimize windbox flow stagnation and NOx emissions from the boiler. However, the boiler performance may be improved by judicious selection of the atomizer spray angle and fuel-steam mixing chamber dimensions to minimize the concentration of oversized spray droplets. To some extent, the formation of coarse spray droplets in the fuel atomizer is also influenced by colloidal flocculation due to a high concentration of stabilizer in the CWF. Thus, the spray quality may be improved by reducing the fuel stabilizer concentration (with negative benefits on the fuel storage life), or by shearing the fuel prior to atomization as a method to disperse fine coal particle flocs. Finally, an improved boiler performance on CWF is also possible with the use of a low free swelling index coal to increase the apparent density of the fly ash. A higher apparent density will increase particle slip in the gas flow and the residence time available for char burnout in the boiler.

The aerodynamic particle size distributions predicted for the fly ash emissions from the boiler are close to the particle size limiting operating range of cyclone collectors. A significant deterioration in cyclone performance below an aerodynamic diameter of 5 μm must be anticipated. The boiler operating conditions have shown that 20-50% of the ash particles finer than an aerodynamic diameter of 5.5 μm may not be removed by a cyclone. The particulate collection efficiency in a cylone may be improved with measures to increase the apparent density of the fly ash.

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The cooperation of staff from the Minas Basin Pulp and Power Co., Cape Breton Development Corporation, Nova Scotia Research Foundation and the Energy Research Laboratories is gratefully acknowledged. Special mention goes to Peter Zwicker, Gordon Breton, Allyn Todd, Neil Stover and Joseph Wong. The contract work by the Nova Scotia Research Foundation was funded by the Canada- Nova Scotia Oil Substitution and

Conservation Agreement, administered by the Nova Scotia Department of Mines and Energy, and Energy, Mines and Resources Canada. The author acknowledges the permission of the Energy Research Laboratories to undertake this work as a cooperative contribution to the joint venture project.

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FIGURE 1. COMBUSTION MECHANISM FOR A BITUMINOUS CWF

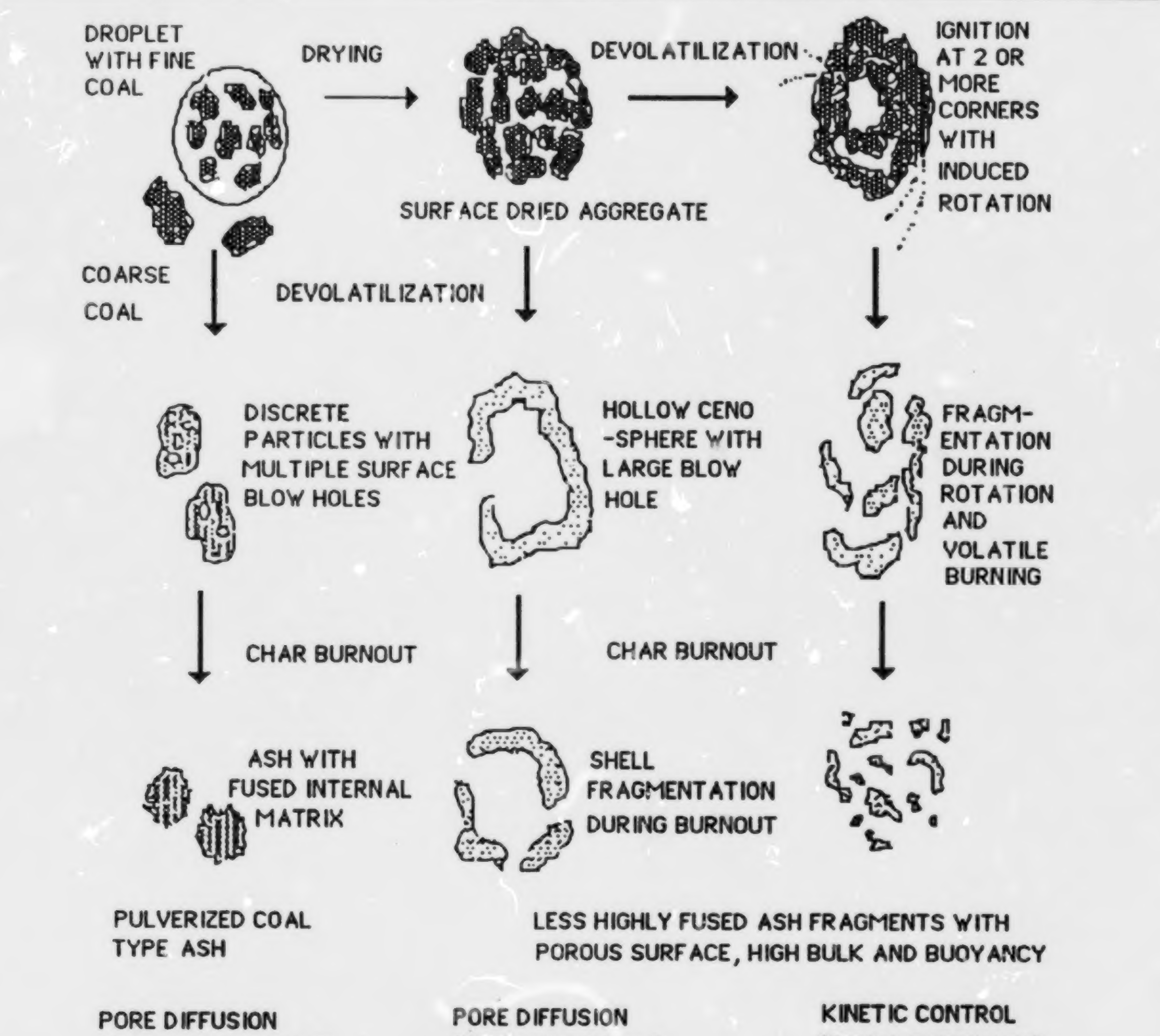

DROPLET WITH FINE COAL
DRYING
SURFACE DRIED AGGREGATE
DEVOLATILIZATION
IGNITION AT 2 OR MORE CORNERS WITH INDUCED ROTATION
COARSE COAL
DEVOLATILIZATION
DISCRETE PARTICLES WITH MULTIPLE SURFACE BLOW HOLES
HOLLOW CENO-SPHERE WITH LARGE BLOW HOLE
FRAGMENTATION DURING ROTATION AND VOLATILE BURNING
CHAR BURNOUT
CHAR BURNOUT
ASH WITH FUSED INTERNAL MATRIX
SHELL FRAGMENTATION DURING BURNOUT
PULVERIZED COAL TYPE ASH
LESS HIGHLY FUSED ASH FRAGMENTS WITH POROUS SURFACE, HIGH BULK AND BUOYANCY
PORE DIFFUSION (COOLER CWF FLAME)
PORE DIFFUSION (THIN CHAR SHELL)
KINETIC CONTROL (SMALL PARTICLES)

FIGURE 2. COMPARISON OF STACK FLY ASH DISTRIBUTIONS; RUN 1

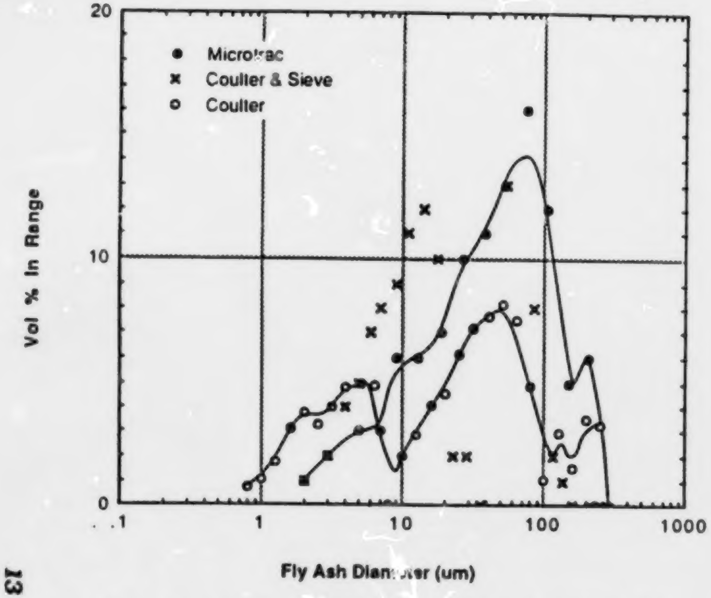


FIGURE 3. COMPARISON OF STACK FLY ASH DISTRIBUTIONS; RUN 2

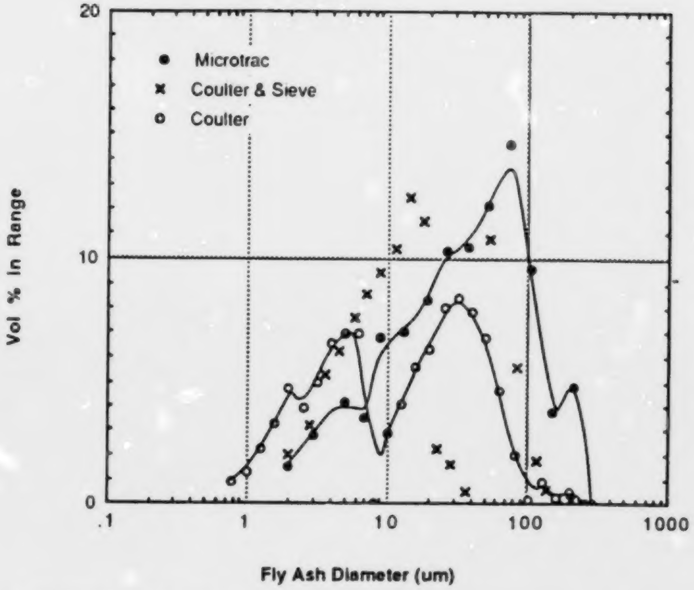


FIGURE 4. COMPARISON OF STACK FLY ASH DISTRIBUTIONS; RUN 3

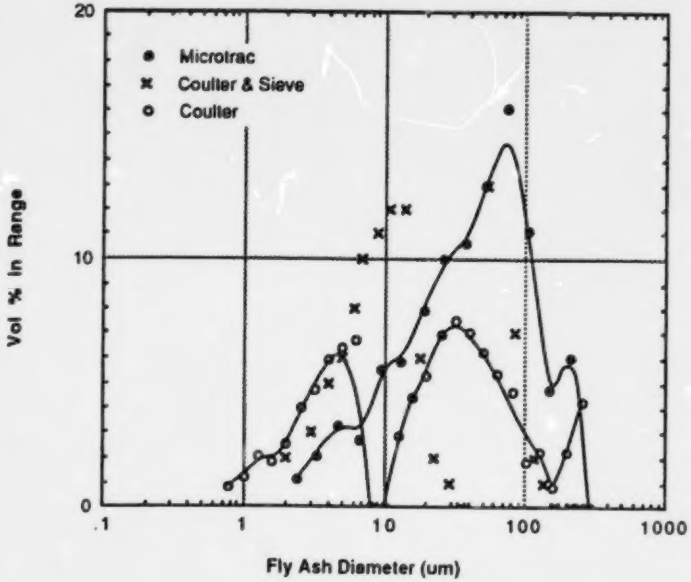


FIGURE 5. COMPARISON OF STACK FLY ASH DISTRIBUTIONS; RUN 4

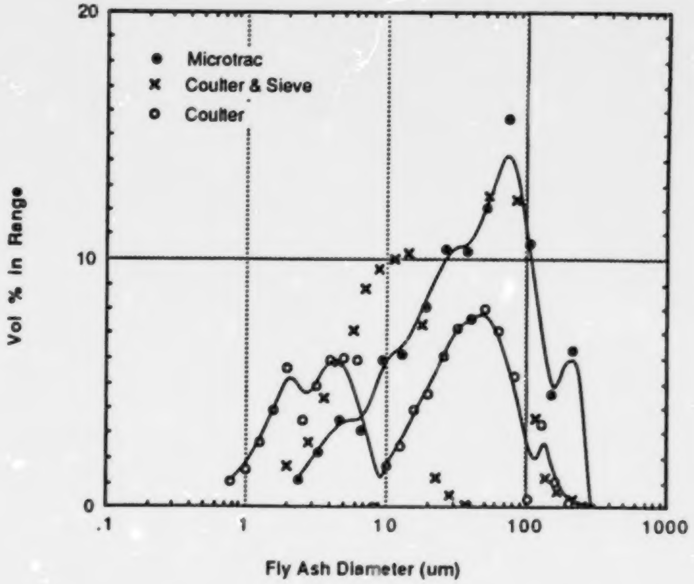


FIGURE 6. COULTER STACK FLY ASH DISTRIBUTION; RUN 1

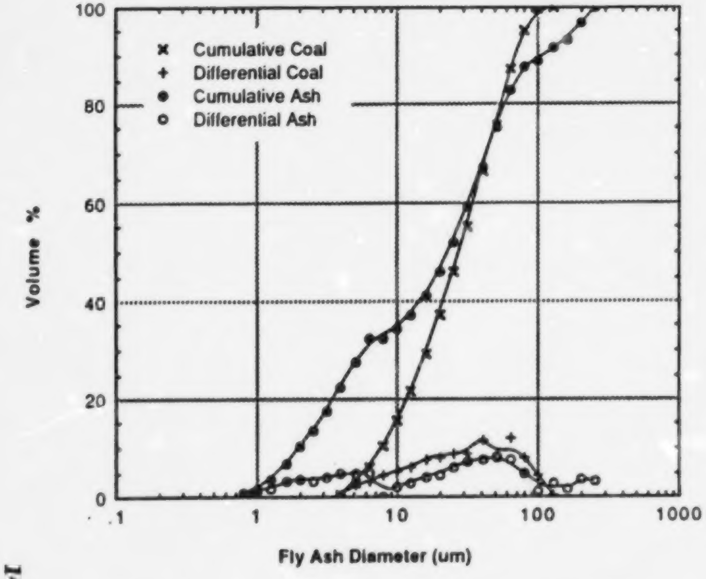


FIGURE 7. COULTER STACK FLY ASH DISTRIBUTION; RUN 2

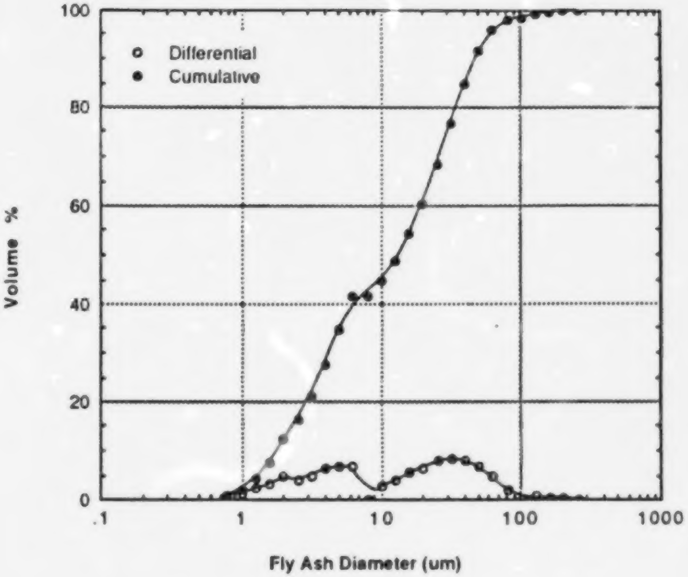


FIGURE 9. COULTER STACK FLY ASH DISTRIBUTION; RUN 4

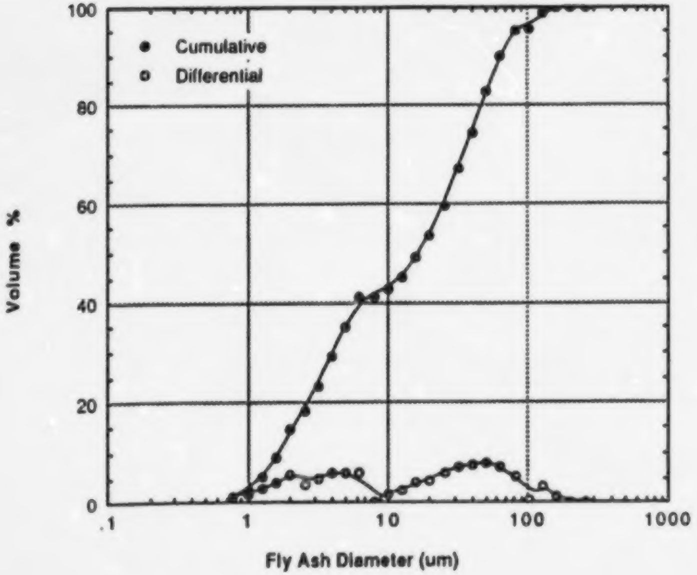
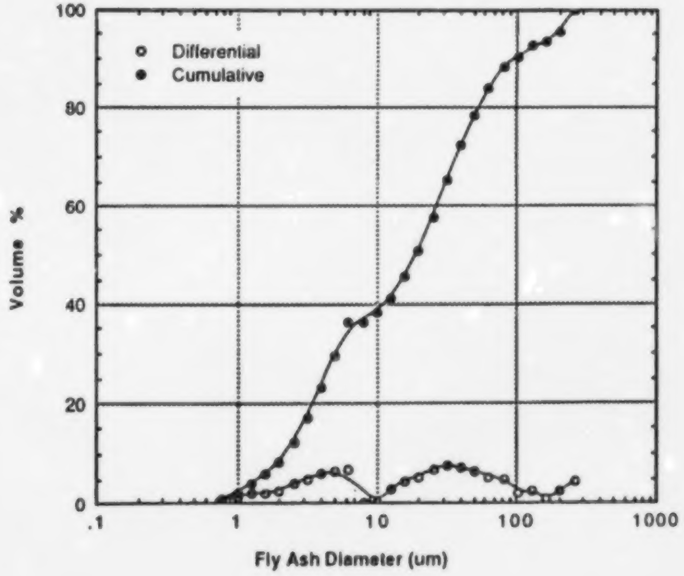


FIGURE 8. COULTER STACK FLY ASH DISTRIBUTION; RUN 3



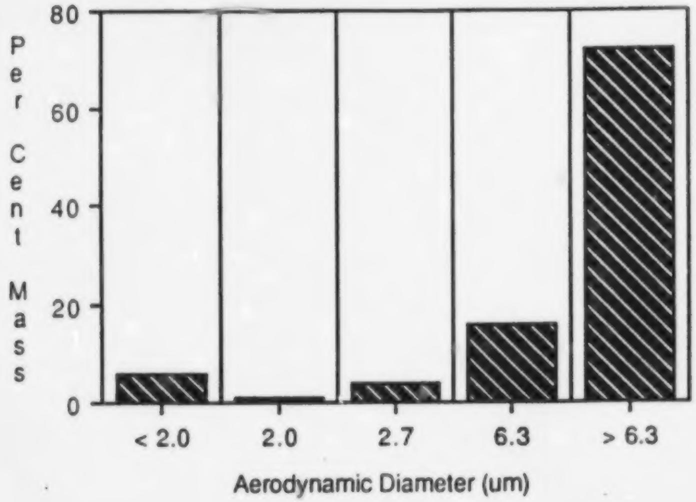


FIGURE 10. RUN 1 CYCLONE PSD

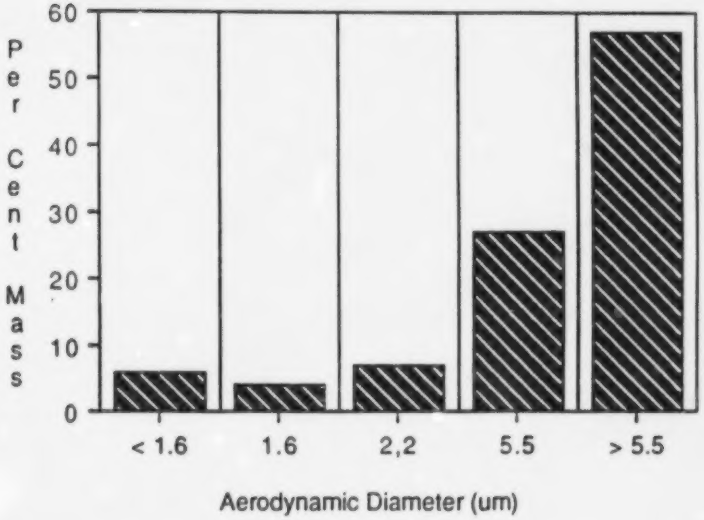


FIGURE 11. RUN 2 CYCLONE PSD

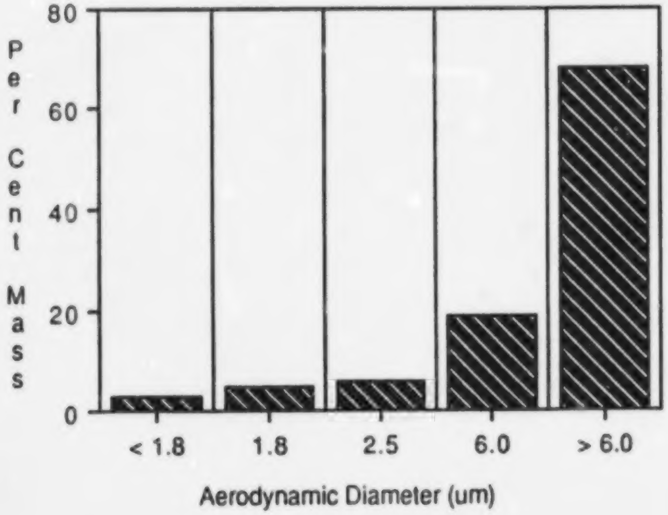


FIGURE 12. RUN 3 CYCLONE PSD

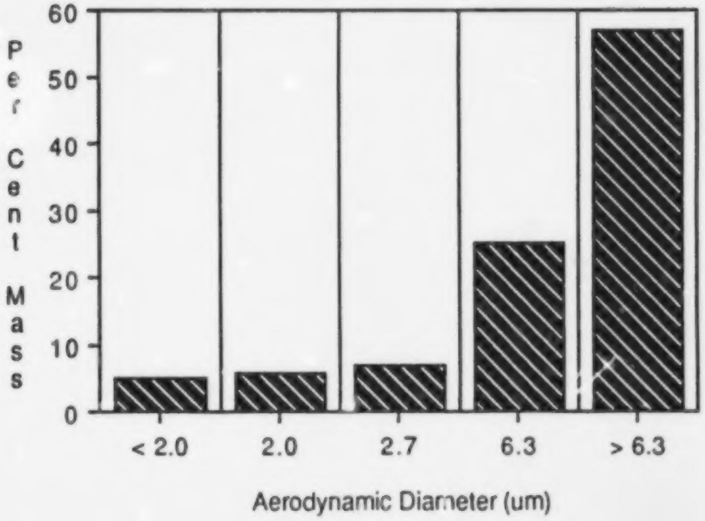


FIGURE 13. RUN 4 CYCLONE PSD

FIGURE 14. RUN 1 STACK FLY ASH

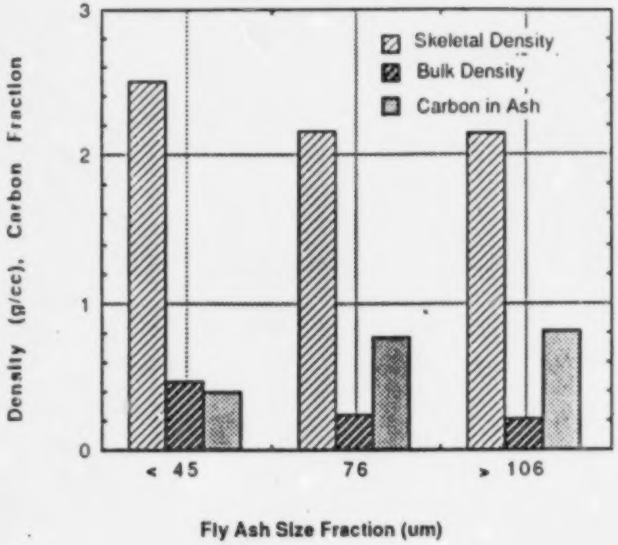


FIGURE 15. RUN 2 STACK FLY ASH

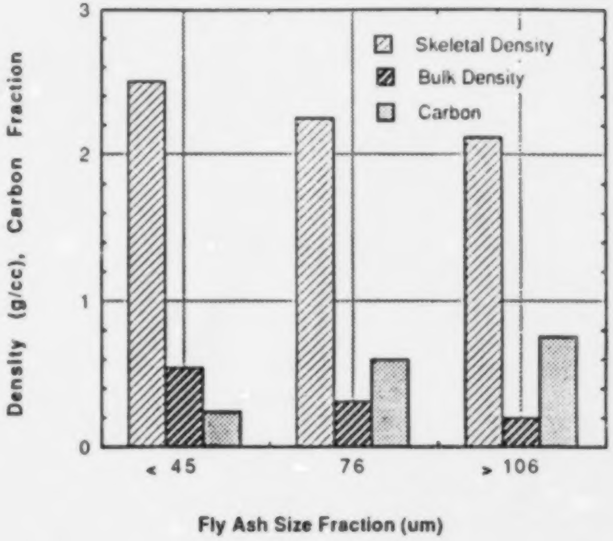


FIGURE 16. RUN 3 STACK FLY ASH

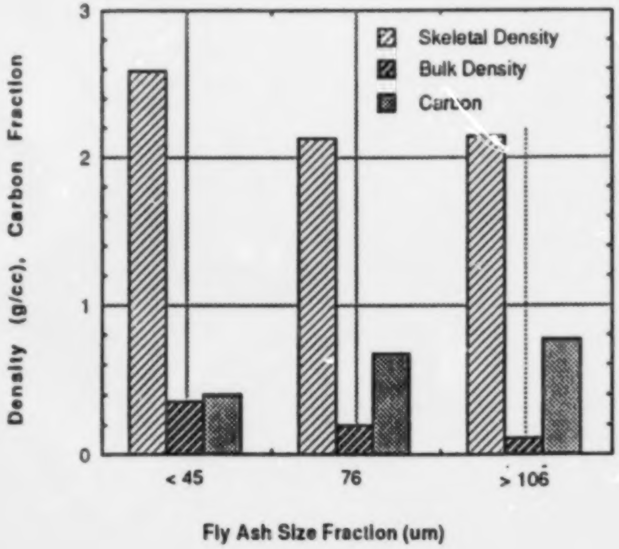


FIGURE 17. RUN 4 STACK FLY ASH

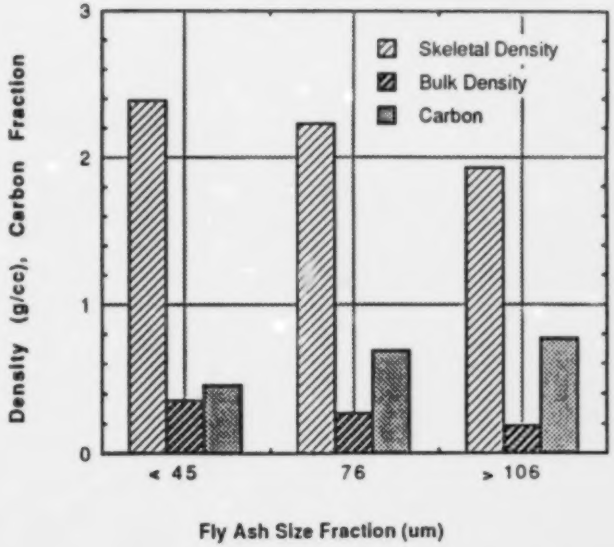
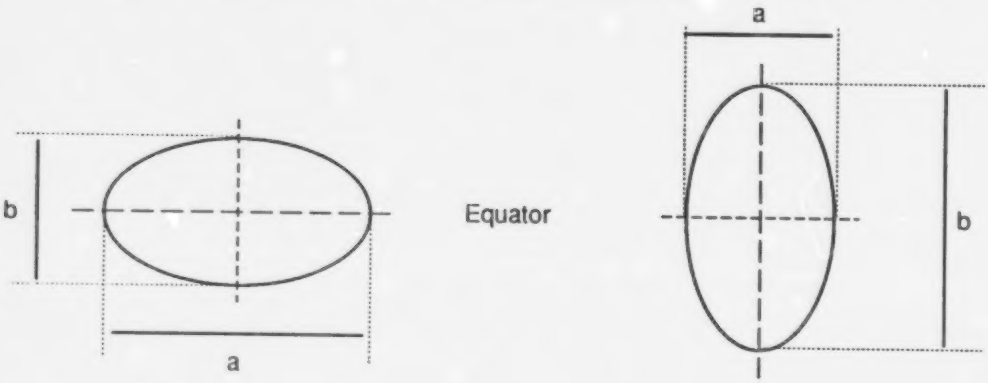


FIGURE 18. DIMENSIONS OF ASSUMED SPHEROIDAL PARTICLE SHAPES


a
b
Equator
b
a

Oblate E < 1

Prolate E > 1

FIGURE 19. AERODYNAMIC DISTRIBUTION OF FLY ASH; RUN 1

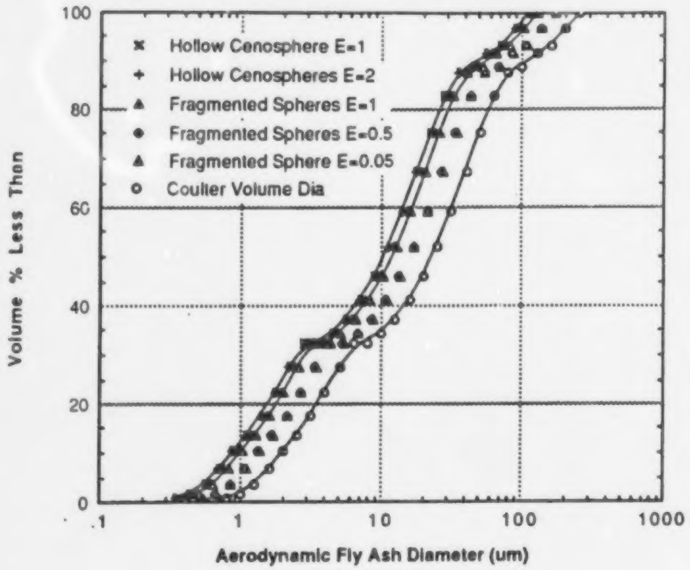


FIGURE 20. AERODYNAMIC DISTRIBUTION OF FLY ASH; RUN 2

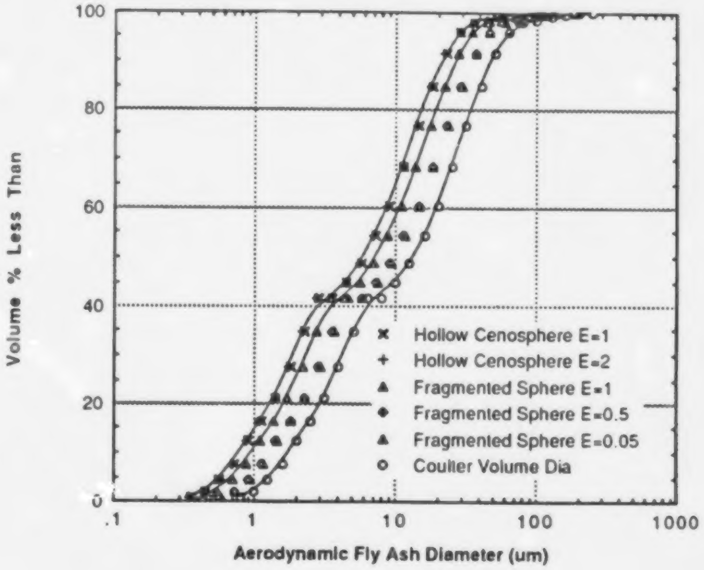


FIGURE 22. AERODYNAMIC DISTRIBUTION OF FLY ASH; RUN 3

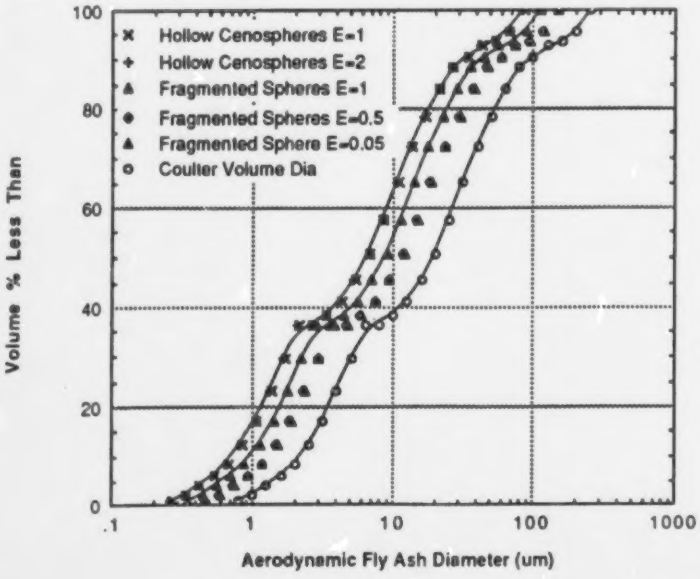


FIGURE 22. AERODYNAMIC DISTRIBUTION OF FLY ASH; RUN 4

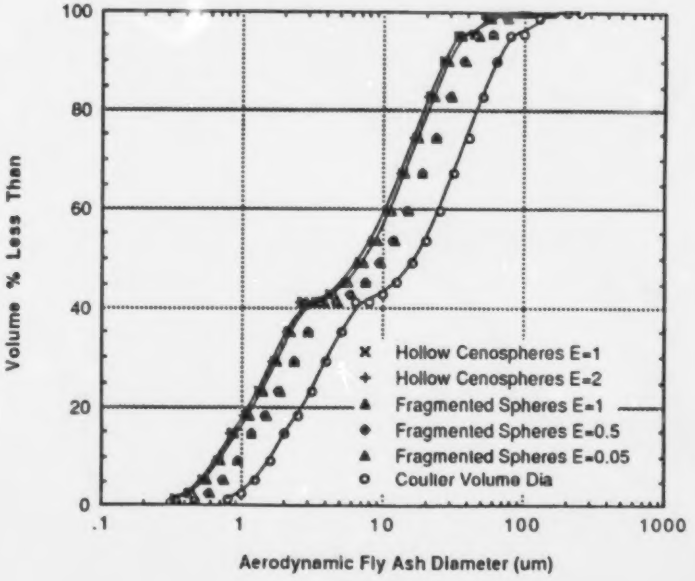


FIG 23 (a) CYCLONE DESIGN EFFICIENCY BASED ON THE STOKES NUMBER

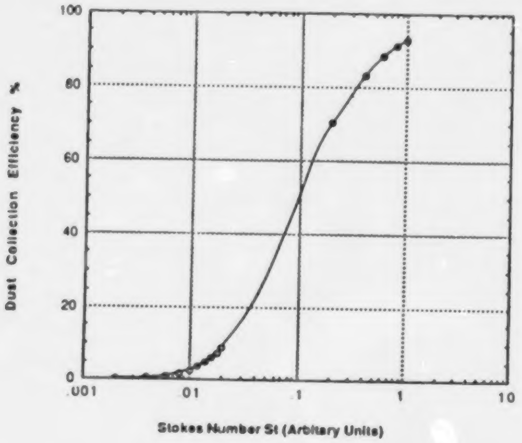


FIG 23 (b) CYCLONE DESIGN EFFICIENCY BASED ON THE AERODYNAMIC DIAMETER

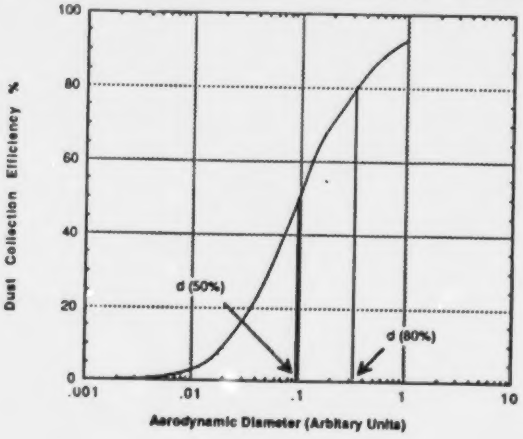


FIGURE 24. FLY ASH SIZE DISTRIBUTION FOR CYCLONE DESIGN

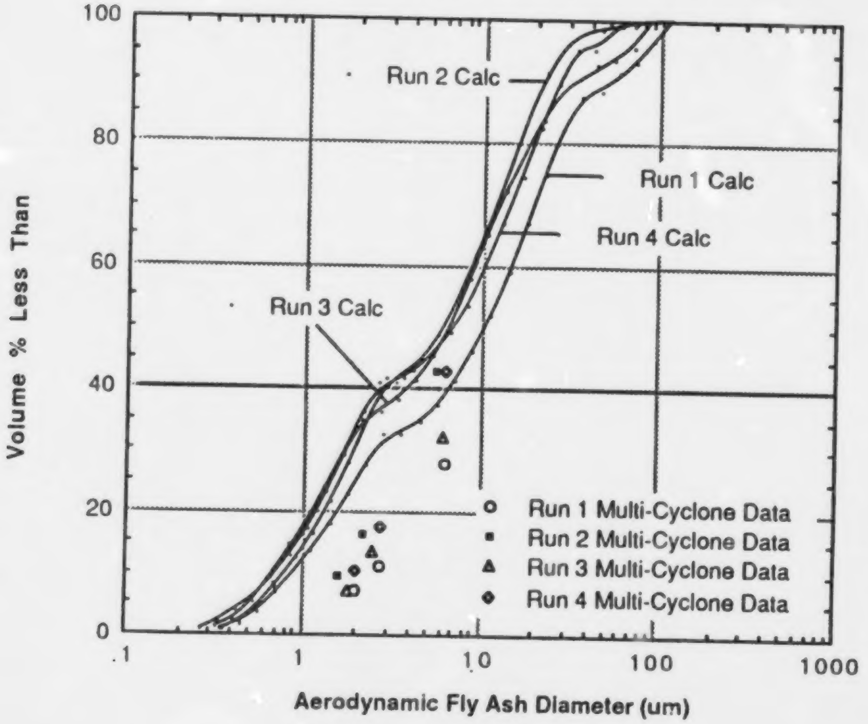


PLATE 1. FLY ASH PARTICLES IN THE >106 μm SIEVE FRACTION

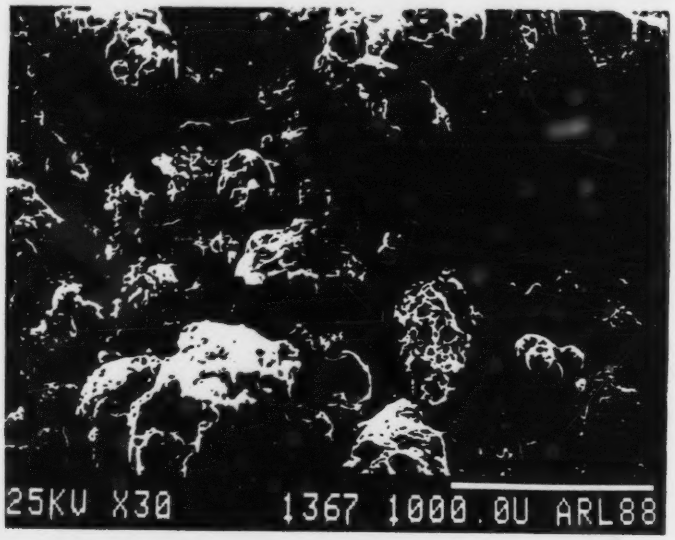

25KV X30 1367 1000.0U ARL88

PLATE 2. FLY ASH PARTICLES IN THE 45-106 μm SIEVE FRACTION

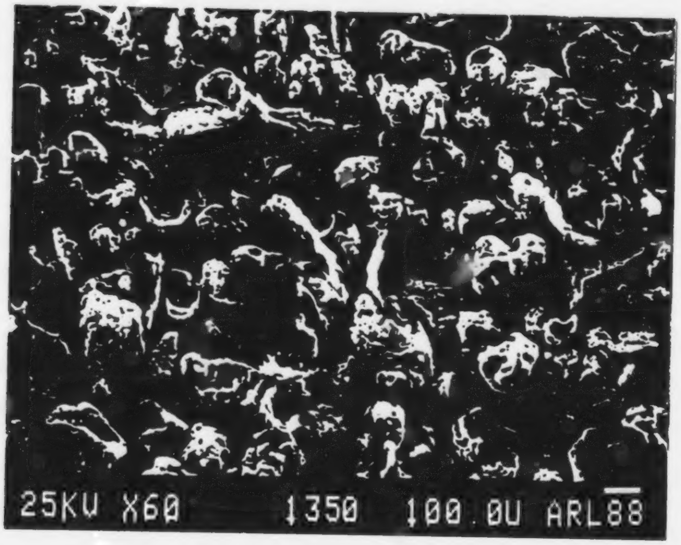
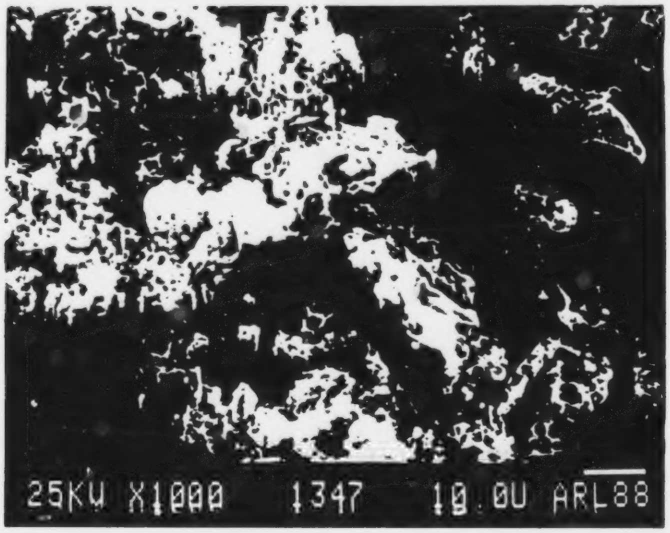

25KV X60 1350 100.0U ARL88

PLATE 3. FLY ASH PARTICLES IN THE <45 μm SIEVE FRACTION


25KV X1000 1347 10.0U ARL88

APPENDIX L

EMR EMISSIONS TEST DATA

A Todd

OPERATING DATA
INDUSTRIAL STEAM BOILER
(WITH STAGING AIR PORTS)

Stack Velocities (ft/s)* 7.99 11.31 7.82 10.27

	RUN 2	RUN 1	RUN 3	RUN 4
Fuel Type	Oil	Coal-Water	Coal-Water	Coal-Water
Rate MW (th)	10.81	10.28	7.41	10.18
Approx. Capacity (%)	53	50	36	50
Steam (kg/h)	13,113	12,114	10,072	13,656
Comb. Air Temp (C)	136	145	132	145
Flue Loading (g/cu. m)	0.12	3.57	3.46	3.89
Flue Ash Content (%)	Oil Soot	~42-56.3	29.2-49.2	34.6-55.9
Fuel Ash Content (%)	-	3.64	3.64	3.64
Fuel Burnout (ash basis %)	-	94.8-97.1	90.8-96.1	92.9-97
Fuel Burnout (CO2 ; %)		~100	91.4	95.4
Stack Gas Temp (°C)	148	159	133.5	153.5
Flue Gas Composition	298F	318F	272 F	303 F
Oxygen (%)	4.5	4.5	5.0	1.0
CO2 (%)	13.5	14.7	12.8	16.5
NOx (ppm)	170	500	270	400
SOx (ppm)	1270	910	889	945

Coal: Total **N** - 1.6%; Total **S** - 1.7%

Fuel burnout assuming 3-4 wt% ash

* Pitot tube measurements

Stack diameter:

MINAS BASIN BOILER RUN 1

Date	880711	880711	870711	870711	
Time	20·45	2100	21·24	21·44	
Steam Rate (K lb/h)	26·8	26·7	30·6	34·5	

Fuel Type (HFO/CWF)	CWF	CWF	CWF	CNF	
Fuel Rate (x 10^6 Btu/h)	35·11	35·08	35·52	35·53	
Fuel Rate (K lb/h)	3344	3341	3383	3384	

Oxygen (%) (Bailey)	4 01	4 22	4·22	3·80	
Air Ratio (fraction)	—	—	—	—	—
Air Flow (K lb/h)	26·6	28·2	28·4	26·8	
Combustion Air Temp (°F)	292·48	292·48	291·52	292·15	
Exhaust Air Temp (°F)	379·62	380·58	379·34	381·13	

Atomizer Fuel Pres (psig)	112	112	113	114	
Atomizer Steam Pres (psig)	135	132	135	135	
Atomizer Steam Flow (~~K~~ lb/h)	902·2	906·6	907·2	907·2	
Atomizer Angle (degrees)	70°	70°	70°	70°	70°
Atomizer Position (in)	15½-16	15½-16	15½-16	15½-16	15½-16

Windbox Press (in)	3·0	3·0	3·0	3·0	
Furnace Press (in)	-0·95	-0·96	-1·12	-0·91	
Outer Burner Press (in)	2·0	2·0	2·0	2·0	
Primary Duct Press (in)	0·5	0·5	0·5	0·25	
Sec Vane Press (in)	-0·75	-0·75	-0·75	-0·75	
Sec Duct Press (in)	—	—	—	—	—
Register Sec Vane Angle (degrees)	60°	60	60	60	60
Tertiary Ports (Open/Closed)	OPEN	OPEN	OPEN	OPEN	OPEN
Primary Damper Position	OPEN	OPEN	OPEN	OPEN	
Sec Damper Position	OPEN	OPEN	OPEN	OPEN	OPEN

Exhaust Gas

O_2	4·5	4·5	5·0	4·7	
CO_2	15·0	16·7	13·5	13.7	
CO (PPM)	10 PPM	10	10	10	
NOx (PPM)	425	500	425	500	
SOx	890	910	848	878	
Temp (°F)	510	510	505	510	

Particulates

Weight (gm)					
Cumulative Air (m^3)					
Time of Sampling (h)					
Stack Temp (°F)					
Conc (~~mg/m3~~) (std) (g/sm³)	3.574				
Carbon (%)					
Fuel Burnout (%)					

Operator Initials					

Comments	Flame good Some sparklers	Started particulate sampling	Almost end particulate sampling	After particulates Full sample taken

Canada Centre for Mineral & Energy Technology

Energy Mines & Resources

MINAS BASIN BOILER

RUN 2

Date	880712	880712	880712		
Time	10.38	11.30			
Steam Rate (K lb/h)	26.8	28.9	28.2		

Fuel Type (HFO/CWF)	HFO	HFO	HFO			
Fuel Rate (x 10^6 Btu/h)	36.76	36.9				
Fuel Rate (K lb/h)	19.87	19.97	20.14			1997

Oxygen (%)	3.69	2.34	2.71			
Air Ratio (fraction)	—	—	—			
Air Flow (K lb/h)	25.6	24.5	25.4			25.
Combustion Air Temp (°F)	277.46	277.0	278.1			
Exhaust Air Temp (°F)	364.2	357.8	360.61			

Atomizer Fuel Pres (psig)	66	67	70		
Atomizer Steam Pres (psig)	105	105	110		
Atomizer Steam Flow (K lb/h)	611.2	624.8	631.4		
Atomizer Angle (degrees)	60	60	60		
Atomizer Position (in)	15"	15"	15"		

Windbox Press (in)	2.0	1.5	2.0		
Furnace Press (in)	-1.10	0.81	-1.27		
Outer Burner Press (in)	0.75	0.5	0		
Primary Duct Press (in)	-0.25	-0.5	-0.5		
Sec Vane Press (in)	-0.5	-0.5	-0.5		
Sec Duct Press (in)	—	—	—		
Register Sec Vane Angle (degrees)	50	50	50		
Tertiary Ports (Open/Closed)	OPEN	OPEN	OPEN		
Primary Damper Position	OPEN	OPEN	OPEN		
Sec Damper Position	OPEN	OPEN	OPEN		

Exhaust Gas

O_2	6.0	4.5	4.5		
CO_2	12.3	13.5	13.5		
CO PPM	5	15	10		
NOx PPM	200	170	175		
SOx PPM	1108	1270	1232		
Temp (°F)	480	475	480		

Particulates

Weight (gm)					
Cumulative Air (m^3)					
Time of Sampling (h)					
Stack Temp (°F)					
Conc ~~(mg/m3)~~ (g/sm³)	0.1183				
Carbon (%)					
Fuel Burnout (%)					

Operator Initials	T.S.	T.S.	T.S.		

Comments		into [illegible] Sampling little smoky	Finished Sampling		

Canada Centre for Mineral & Energy Technology

Energy Mines & Resources

MINAS BASIN BOILER R 1113

Date	880712	880712	880712	880712	880712
Time	15.34	1605	1634	1700	
Steam Rate (K lb/h)	25.9	22.2	18.7	22.6	17.9

Fuel Type (HFO/CWF)	CWF	CWF	CWF	CWF	CWF	
Fuel Rate (x 10⁶ Btu/h)	25.4	25.3	25.2	25.4		
Fuel Rate (K lb/h)	2418	2414	2404	2421	2404	2412

Oxygen (%)	4.04	4.21	4.12	3.95	4.08	
Air Ratio (fraction)	—	—	—	—	—	
Air Flow (K lb/h)	15.0	19.7	20.0	19.3	17.5	18.3
Combustion Air Temp (°F)	272.6	270.4	272.8	274.5	275.4	
Exhaust Air Temp (°F)	343.4	338.7	343.1	344.5	344.6	

Atomizer Fuel Pres (psig)	86	86	86	88	88
Atomizer Steam Pres (psig)	117	117	120	120	120
Atomizer Steam Flow (K lb/h)	790.1	855.0	820	805	807
Atomizer Angle (degrees)	70	70	70	70	70
Atomizer Position (in)	14½-15	14½-15"	14½-15"	14½-15	14½-15

Windbox Press (in)	1.5	1.5	1.5	1.5	1.0
Furnace Press (in)	-0.88	-0.89	-0.94	-0.99	-1.1
Outer Burner Press (in)	0	0	0	0	0
Primary Duct Press (in)	-0.5	-0.5	-0.5	-0.5	-0.5
Sec Vane Press (in)	-0.5	-0.75	-0.75	-0.75	-0.75
Sec Duct Press (in)	—	—	—	—	—
Register Sec Vane Angle (degrees)	60	60	60	60	60
Tertiary Ports (Open/Closed)	OPEN	OPEN	OPEN	OPEN	OPEN
Primary Damper Position	OPEN	OPEN	OPEN	OPEN	OPEN
Sec Damper Position	OPEN	OPEN	OPEN	OPEN	OPEN

Exhaust Gas

O_2	5.0	5.0	5.0	5.0	5.0
CO_2	13.3	12.8	13.0	12.8	12.5
CO PPM	10	10	10	10	10
NOx PPM	300	270	270	300	270
SOx PPM	872	889	877	860	796
Temp (°F)	455	450	455	455	455

Particulates

Weight (gm)					
Cumulative Air (m³)					
Time of Sampling (h)					
Stack Temp (°F)					
Conc ~~(mg/m³)~~ (g/sm³)	3.461				
Carbon (%)					
Fuel Burnout (%)					

Operator Initials	T.S.				
Comments		Into sampling	Finished sampling		

Drum level causing

Dr to [illegible]

[illegible]

MINAS BASIN BOILER Run 4

Date	880713	880713	880713	880713	
Time	10.51	11.29	12.04	12.23	
Steam Rate (K lb/h)	29.1	29.9	30.1	31.6	

Fuel Type (HFO/CWF)	CWF	CWF	CWF	CWF	
Fuel Rate (x 10^6 Btu/h)					
Fuel Rate (K lb/h)	3341	3357	3308	3336	

333

Oxygen (%)	2.29	1.90	1.94	2.06	
Air Ratio (fraction)	–	–	–	–	
Air Flow (K lb/h)	31.8	29.3	28.4	28.2	
Combustion Air Temp (°F)	289.7	290	293	292	
Exhaust Air Temp (°F)	379.8	379	380	379	

29.

Atomizer Fuel Pres (psig)	105	104	104	102	
Atomizer Steam Pres (psig)	135	130	130	130	
Atomizer Steam Flow (K lb/h)	863	849	862	865	
Atomizer Angle (degrees)	70	70	70	70	
Atomizer Position (in)	14½-15	16½-15	14½-15	14½-15	

Windbox Press (in)	2.0	2.0	2.0	2.0	
Furnace Press (in)	-1.14	-1.03	-1.05	-0.95	
Outer Burner Press (in)	1.0	1.0	1.0	1.0	
Primary Duct Press (in)	-0.5	-0.25	-0.25	-0.25	
Sec Vane Press (in)	-1.0	-0.75	-0.75	-0.75	
Sec Duct Press (in)	–	–	–	–	
Register Sec Vane Angle (degrees)	60	60	60	60	
Tertiary Ports (Open/Closed)	OPEN	OPEN	OPEN	OPEN	
Primary Damper Position	OPEN	OPEN	OPEN	OPEN	
Sec Damper Position	OPEN	OPEN	OPEN	OPEN	

Exhaust Gas

O_2	3.0	2.5	1.0	1.0	
CO_2	16.3	16.5	16.5	17.3	
CO ppm	5-10	5-10	5-10	5-10	
NOx ppm	400	450	400	425	
SOx ppm	970	992	945	962	
Temp (°F)	505	500	500	500	

Particulates

Weight (gm)					
Cumulative Air (m^3)					
Time of Sampling (h)					
Stack Temp (°F)					
Conc ~~(mg/m^3)~~ g/sm^3	3.8901				
Carbon (%)					
Fuel Burnout (%)					

Operator Initials	[illegible]	T.S.	T.S.	T.S.	

Comments	Before sampling Good Flame Cleanish stack.	During sampling	End sampling		

Canada Centre for Mineral & Energy Technology

Energy Mines & Resources

APPENDIX M

EMISSIONS DATA PLOTS

CWF EMISSIONS TESTING - ORTECH International.

Page 1

SHIFT OPERATOR LOG - BOILER #7

MINAS BASIN PULP & POWER

Next Page Also

DATE: 93/11/09	SHIFT:	OPERATOR: Tony Starratt							Nov9
TIME	19:12	19:30	19:45	20:00	20:15	20:30	20:45	21:00	4-12
STEAM FLOW (Klb\hr)	35.3	35.7	35.6	35.5	36.7	35.6	36.1	35.3	36.0
FUEL TYPE (CWF/HFO)	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF
FUEL FLOW (lb/hr)	4050	4003	3996	4013	4001	3958	[illegible]	4002	4005
AIR FLOW (Klb/hr)	45.1	43.2	46.4	43.6	46.6	43.9	[illegible]	[illegible]	449
AIR RATIO	.7944	.7944	.7944	.7954	.7944	.7954	.7944	.7944	0.7944
OXYGEN (%)									—
ATM STEAM FLOW (lb/hr)	1075	1075	1078	1080	1082	1079	1087	1086	1084
FURNACE PRESS. (in)	-1.14	-0.90	-0.86	-1.14	-1.33	-1.31	-1.07	-0.80	-0.99
EXHAUST TEMP (F)									—
COMB AIR TEMP (F)	304	305	305	305	304	304	303	303	302
CWF TANKS (kg)	NA	-	-						—
SEC VANE ANGLE (deg)	50	50	50	50	50	50	50	50	50
PRIM DAMPER POS (in)	3	3	3	3	3	3	3	3	3
SEC DAMPER POS (in)	6	6	6	6	6	6	6	6	6
TERT DAMPER POS (o/c)	0	0	0	0	0	0	0	0	0
GUN ID #	2	2	2	2	2	2	2	2	2
GUN POSITION (in)	16	16	16	16	16	16	16	16	16
WINDBOX PRESS (in)	6	5	6	6	8	8	8	8	7.5
ATM STEAM PRESS (psig)	150	150	150	155	153	155	155	153	153
FUEL PRESS (psig)	84	80	86	84	86	84	84	82	82
STRAINER DIFF (psid)									
FW PRESS (psig)	210	210	210	210	210	210	210	210	210
FW TEMP (F)	230	228	230	224	224	224	220	224	223
DA PRESS (psig)	8	6	8	9	8	9	4	8	7.1
SOOTBLOW (time/duration)									
CLEAN STRAINER (#/time)									
NEW CERAMICS (time/type/gun#)									

COMMENTS:
(Note shutdowns/startups /tip & strainer changes/ time/etc.)

CWF Emissions testing - ORTECH International

Page 2

SHIFT OPERATOR LOG - BOILER #7

MINAS BASIN PULP & POWER

Nov 9 4-
Next
Also.

DATE: 88/11/07	SHIFT:		OPERATOR: Tony Starratt					
TIME	21:15	21:30	21:46	22:00	22:15	22:30	22:45	23:00
STEAM FLOW (Klb\hr)	36.6	36.5	36.7	35.6	35.4	34.8	35.3	36.4
FUEL TYPE (CWF/HFO)	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF
FUEL FLOW (lb/hr)	4002	3988	3981	3985	4000	4016	4019	3944
AIR FLOW (Klb/hr)	44.7	45.7	44.4	44.5	43.3	44.8	46.2	44.4
AIR RATIO	.7944	.7944	.7944	.7944	.7944	.7944	.7944	.7944
OXYGEN (%)	–							
ATM STEAM FLOW (lb/hr)	1087	1078	1080	1086	1088	1091	1092	1088
FURNACE PRESS. (in)	-0.93	-0.97	-1.30	-1.02	-0.80	-0.81	-0.91	-0.94
EXHAUST TEMP (F)								
COMB AIR TEMP (F)	302	301	301	300	301.38	301	301	300
CWF TANKS (kg)	N/A							
SEC VANE ANGLE (deg)	50	50	50	50	50	50	50	50
PRIM DAMPER POS (in)	3	3	3	3	3	3	3	3
SEC DAMPER POS (in)	6	6	6	6	6	6	6	6
TERT DAMPER POS (o/c)	0	0	0	0	0	0	0	0
GUN ID #	2	2	2	2	2	2	2	2
GUN POSITION (in)	16	16	16	16	16	16	16	16
WINDBOX PRESS (in)	8	8	8	8	8	8	8	8
ATM STEAM PRESS (psig)	155	155	153	152	155	155	155	152
FUEL PRESS (psig)	82	80	80	80	81	80	82	82
STRAINER DIFF (psid)								
FW PRESS (psig)	210	210	210	210	210	210	210	210
FW TEMP (F)	224	226	218	224	218	230	218	226
DA PRESS (psig)	4	6	6	8	4	9	6	5
SOOTBLOW (time/duration)								
CLEAN STRAINER (#/time)								
NEW CERAMICS (time/type/gun#)								

COMMENTS:
(Note shutdowns/startups
/tip & strainer changes/
time/etc.)

ADD TO Page 1

CWF Emissions testing - ORTECH International

Page 3

SHIFT OPERATOR LOG - BOILER #7

MINAS BASIN PULP & POWER

Nov 10
12-8

Next 3
295.0150

ADD TO Pg.1

DATE: 88/11/09	SHIFT:		OPERATOR: T. STARRATT / J. DOUCET						
TIME	23:15	23:30	23:45	0000	0015	0030	0045	0100	
STEAM FLOW (Klb\hr)	36.3	36.7	36.6	36.8	36.8	33.9	35.4	37.1	37.0
FUEL TYPE (CWF/HFO)	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF
FUEL FLOW (lb/hr)	4017	4060	4036	4024	4031	4000	4043	4038	4026
AIR FLOW (Klb/hr)	43.1	46.8	45.7	44.9	41.9	[illegible]	45.8	43.1	46.3
AIR RATIO	.7944	.7944	.7944	.7944	.7944	.7944	.7944	.7944	0.7944
OXYGEN (%)			–	–	–	–	–	–	
ATM STEAM FLOW (lb/hr)	1085	1090	1093	1091	1091	1098	1091	1093	1095
FURNACE PRESS. (in)	-1.14	-0.94	-1.14	-1.17	-1.15	-0.82	-1.06	-0.89	-1.01
EXHAUST TEMP (F)			–	–	–	–	–	–	
COMB AIR TEMP (F)	300	300	299.6	299.5	300	301.7	302.5	303.2	301
CWF TANKS (kg)									
SEC VANE ANGLE (deg)	50	50	50	50	50	50	50	50	50
PRIM DAMPER POS (in)	3	3	[illegible]	3	3	3	3	3	3
SEC DAMPER POS (in)	6	6		6	6	6	6	6	6
TERT DAMPER POS (o/c)	0	0	0	0	0	0	0	0	0
GUN ID #	2	2	2	2	2	2	2	2	2
GUN POSITION (in)	16	16	16	16	16	16	16	16	16
WINDBOX PRESS (in)	8	8	8	8	8	8	8	8	8
ATM STEAM PRESS (psig)	150	150	150	151	150	156	150	150	150
FUEL PRESS (psig)	78	76	78	78	77	80	76	76	72
STRAINER DIFF (psid)			–	–	–	–	–	–	–
FW PRESS (psig)	210	210	215	212	218	215	212	204	210
FW TEMP (F)	220	218	222	224	224	220	222	208	216
DA PRESS (psig)	8	8	7	7	9	5	5	0	4.5
SOOTBLOW (time/duration)									
CLEAN STRAINER (#/time)									
NEW CERAMICS (time/type/gun#)									

COMMENTS:

(Note shutdowns/startups /tip & strainer changes/ time/etc.)

CWF EMISSIONS TESTING - ORTECH INTERNATIONAL

PAGE 4

SHIFT OPERATOR LOG - BOILER #7

MINAS BASIN PULP & POWER

NOV 10 1,2-8

ADD pg 3

ACTUALLY 10th

DATE: 88/11/09	SHIFT:		OPERATOR:	J. DOUCET					
TIME	0115	0130	0145	0200	0216	0230	0245	0300	
STEAM FLOW (Klb\hr)	35.8	35.7	37.5	37.9	41.1	37.9	37	37.9	37.6
FUEL TYPE (CWF/HFO)	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF
FUEL FLOW (lb/hr)	4001	4024	4017	4036	4017	4057	4010	4034	4025
AIR FLOW (Klb/hr)	44.3	43.4	46	46.2	45.5	46.4	47	48.4	45.9
AIR RATIO	.7944	.7944	.7944	.7944	.7944	.7944	.7944	.7944	0.794
OXYGEN (%)	-	-	-	-	-	-	-	-	-
ATM STEAM FLOW (lb/hr)	1098	1093	1092	1092	1087	1094	1094	1090	1093
FURNACE PRESS. (in)	-1.22	-1.12	-0.69	-0.61	-1.11	-1.31	-1.36	-1.33	-1.09
EXHAUST TEMP (F)	-	-	-	-	-	-	-	-	-
COMB AIR TEMP (F)	300.7	301	300.8	301.4	301.2	301.1	301.2	301.2	301
CWF TANKS (kg)	-	-	-	-	-	-	-		-
SEC VANE ANGLE (deg)	50	50	50	50	50	50	50	50	50
PRIM DAMPER POS (in)	3	3	3	3	3	3	3	3	3
SEC DAMPER POS (in)	6	6	6	6	6	6	6	6	6
TERT DAMPER POS (o/c)	0	0	0	0	0	0	0	0	0
GUN ID #	2	2	2	2	2	2	2	2	2
GUN POSITION (in)	16	16	16	16	16	16	16	16	16
WINDBOX PRESS (in)	8	8	8	8	8	8	8	8	8
ATM STEAM PRESS (psig)	150	150	150	150	148	148	150	150	150
FUEL PRESS (psig)	74	72	73	74	74	72	72	72	73
STRAINER DIFF (psid)	-	-	-	-	-	-	-	-	-
FW PRESS (psig)	204	210	208	212	210	212	212	210	210
FW TEMP (F)	216	214	218	220	217	218	210	219	216
DA PRESS (psig)	0	6	2	8	7	6	6	4	4.9
SOOTBLOW (time/duration)									
CLEAN STRAINER (#/time)									
NEW CERAMICS (time/type/gun#)									

COMMENTS:

(Note shutdowns/startups /tip & strainer changes/ time/etc.)

CWF EMISSIONS TESTING - ORTECH INTERNATIONAL

PAGE 5

SHIFT OPERATOR LOG - BOILER #7

MINAS BASIN PULP & POWER

Nov 10 12-8

ADD T Pg 3

DATE: 88/11/10	SHIFT: 12-8	OPERATOR:	J DOUCET						
TIME	0315	0330	0346	0400	0415	0430	0445	0500	
STEAM FLOW (Klb\hr)	39	42	37.6	34.9	32.7	35.5	37.7	36.4	37.6
FUEL TYPE (CWF/HFO)	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF
FUEL FLOW (lb/hr)	4045	4054	4055	4017	4045	4050	4064	3996	4041
AIR FLOW (Klb/hr)	45.3	47.6	47.6	47.4	47.1	46.3	47.8	48.1	47.2
AIR RATIO	.7944	.7944	.7944	.7944	.7944	.7944	.7944	.7944	0.794
OXYGEN (%)	-	-	-	-	-	-	-	-	
ATM STEAM FLOW (lb/hr)	1090	1087	1094	1093	1104	1095	1096	1095	1094
FURNACE PRESS. (in)	-1.15	-0.63	-0.88	-0.93	-1.34	-0.75	-0.99	-1.16	-0.98
EXHAUST TEMP (F)	-	-	-	-	-	-	-	-	-
COMB AIR TEMP (F)	300.4	299	297.5	299.3	299.9	300.3	300.4	300.7	300
CWF TANKS (kg)	-	-	-	-	-	-	-	-	-
SEC VANE ANGLE (deg)	50	50	50	50	50	50	50	50	50
PRIM DAMPER POS (in)	3	3	3	3	3	3	3	3	3
SEC DAMPER POS (in)	6	6	6	6	6	6	6	6	6
TERT DAMPER POS (o/c)	0	0	0	0	0	0	0	0	0
GUN ID #	2	2	2	2	2	2	2	2	2
GUN POSITION (in)	16	16	16	16	16	16	16	16	16
WINDBOX PRESS (in)	8	8	8	8	8	8	8	8	8
ATM STEAM PRESS (psig)	149	142	149	150	150	150	150	150	149
FUEL PRESS (psig)	72	68	71	72	72	71	70	71	7
STRAINER DIFF (psid)	-	-	-	-	-	-	-	-	-
FW PRESS (psig)	212	202	204	212	210	212	208	214	20
FW TEMP (F)	216	211	217	216	216	208	210	220	21
DA PRESS (psig)	7	0	2.5	7	2	6	0	6	3.
SOOTBLOW (time/duration)									
CLEAN STRAINER (#/time)									
NEW CERAMICS (time/type/gun#)									

COMMENTS:
(Note shutdowns/startups /tip & strainer changes/ time/etc.)

CWF EMISSIONS TESTING - ORTECH INTERNATIONAL

PAGE 6

SHIFT OPERATOR LOG - BOILER #7

MINAS BASIN PULP & POWER

Nov10/88

DATE: 88/11/10	SHIFT: 12-8 OPERATOR: J. DOUCET								ADD TO
TIME	0515	0533	0545	0600	0615	0630	0645	0700	
STEAM FLOW (Klb\hr)	37.3	37.9	37	36.8	37.5	35.6	36.6	33.4	36.
FUEL TYPE (CWF/HFO)	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF	CWF
FUEL FLOW (lb/hr)	3985	4003	4029	4062	3985	4048	4000	3987	401
AIR FLOW (Klb/hr)	47	49	46.5	46.8	46.7	46.8	47.5	46.8	47.1
AIR RATIO	.7944	.7944	.7944	.7944	.7944	.7944	.7944	.7944	0.79
OXYGEN (%)	–	–	–	–	–	–	–	–	–
ATM STEAM FLOW (lb/hr)	1094	1094	1101	1101	1098	1095	1095	1102	1098
FURNACE PRESS. (in)	-1.07	-0.74	-1.21	-1.02	-0.79	-1.02	-0.91	-0.98	-0.9
EXHAUST TEMP (F)	–	–	–	–	–	–	–	–	–
COMB AIR TEMP (F)	301.1	300.8	301.1	301	300.7	299.6	300.6	299.5	301
CWF TANKS (kg)	–	–	–	–	–	–	–	–	–
SEC VANE ANGLE (deg)	50	50	50	50	50	50	50	50	50
PRIM DAMPER POS (in)	3	3	3	3	3	3	3	3	3
SEC DAMPER POS (in)	6	6	6	6	6	6	6	6	6
TERT DAMPER POS (o/c)	0	0	0	0	0	0	0	0	0
GUN ID #	2	2	2	2	2	2	2	2	2
GUN POSITION (in)	16	16	16	16	16	16	16	16	16
WINDBOX PRESS (in)	8	8	8	8	8	8	8	8	8
ATM STEAM PRESS (psig)	150	150	150	150	150	150	150	150	150
FUEL PRESS (psig)	71	70	68	70	70	70	68	69	7
STRAINER DIFF (psid)	–	–	–	–	–	–	–	–	–
FW PRESS (psig)	212	211	208	210	212	208	210	206	21
FW TEMP (F)	215	216	218	218	220	204	218	210	21
DA PRESS (psig)	6	2	7	3	7	0	5	5	4.
SOOTBLOW (time/duration)									
CLEAN STRAINER (#/time)									
NEW CERAMICS (time/type/gun#)									

COMMENTS:

(Note shutdowns/startups /tip & strainer changes/ time/etc.)

ORTECH EXTRA GAS TEST
at end of [illegible] CWF test 3

CAPE BRETON DEVELOPMENT CORPORATION
MINAS BASIN PULP AND POWER
BOILER #7 CWF
11-10-1988

08:04:09 OPERATOR REDUCING AIR IN STEPS
08:57:47 8:56:30 OPEN 3 AIR
09:08:56 CLOSED 3 DAMPER 9:07:30
09:19:31 THE END

TIME	O2	CO2	S02-2	CO	NOx	THC	FLOW
07:06:00	9.70	9.75	902	143	238	5.2	5.0
07:08:00	9.59	9.82	908	137	238	4.8	5.0
07:10:00	9.70	9.75	904	137	238	4.4	5.0
07:12:00	9.62	9.80	911	136	238	4.4	5.0
07:14:00	9.72	9.71	904	145	236	5.0	4.9
07:16:00	9.65	9.78	907	139	239	4.4	4.9
07:18:00	9.63	9.82	913	139	239	4.5	4.9
07:20:00	9.66	9.78	908	144	238	4.6	4.9
07:22:00	9.70	9.75	906	141	237	4.4	4.9
07:24:00	9.62	9.82	909	142	238	4.6	4.9
07:26:00	9.57	9.87	916	140	238	4.5	4.9
07:28:00	9.62	9.80	910	150	237	4.8	4.9
07:30:00	9.55	9.89	918	139	238	4.3	4.9
07:32:00	9.61	9.83	913	147	237	4.6	4.9
07:34:00	9.66	9.82	912	146	238	4.3	4.9
07:36:00	9.56	9.87	918	144	239	4.3	4.8
07:38:00	9.63	9.81	915	143	238	4.1	5.1
07:40:00	9.58	9.88	919	137	238	4.0	5.1
07:42:00	9.64	9.82	912	143	238	4.0	5.0
07:44:00	9.63	9.83	914	144	238	4.2	5.0
07:46:00	9.65	9.82	913	142	236	4.2	5.0
07:48:00	9.59	9.87	916	141	237	4.0	5.0
07:50:00	9.46	9.97	923	133	238	3.8	5.0
07:52:00	9.65	9.82	911	145	236	4.1	5.0
07:54:00	9.66	9.82	912	143	236	3.9	5.0
07:56:00	9.61	9.87	915	139	237	3.8	5.0
07:58:00	9.28	10.12	940	128	239	3.3	5.0
08:00:00	8.76	10.56	988	119	242	2.4	5.0
08:02:00	8.41	10.81	1021	109	243	2.5	5.0
08:04:10	8.42	10.81	1017	108	243	2.2	5.0
08:06:00	7.66	11.46	1080	95	245	1.4	5.0
08:08:00	6.89	12.04	1152	88	246	1.2	5.1
08:09:00	6.76	12.15	1158	87	245	1.2	5.1
08:10:00	6.66	12.15	1165	86	244	1.1	5.0
08:11:00	5.91	13.06	1241	85	241	0.7	5.1
08:12:00	4.14	14.18	1418	93	239	0.5	5.1
08:12:30	4.10	14.21	1419	88	239	0.6	5.1
08:13:00	4.16	14.12	1406	91	234	0.7	5.1
08:13:30	4.24	14.10	1398	91	238	0.7	5.1
08:14:00	4.37	14.09	1402	94	234	0.5	5.1
08:14:30	4.22	14.26	1418	90	237	0.7	5.1
08:15:00	4.03	14.45	1436	103	234	1.3	5.0
08:15:30	3.08	15.23	1533	150	232	0.6	5.0
08:16:00	2.37	15.71	1594	142	242	1.2	5.1
08:16:30	2.05	15.96	1619	171	237	1.3	5.1
08:17:00	1.67	16.00	1637	194	237	1.7	5.0
08:17:30	1.61	15.98	1622	186	241	1.4	5.0

CAPE BRETON DEVELOPMENT CORPORATION
MINAS BASIN PULP AND POWER
BOILER #7 CWF
11-10-1988

08:04:09 OPERATOR REDUCING AIR IN STEPS
08:57:47 8:56:30 OPEN 3 AIR
09:08:56 CLOSED 3 DAMPER 9:07:30
09:19:31 THE END

TIME	O2	CO2	S02-2	CO	NOx	THC	FLOW
08:18:00	1.83	15.92	1613	181	235	1.9	5.0
08:18:30	1.79	15.99	1622	211	234	1.0	5.0
08:19:00	1.61	16.14	1633	181	239	1.4	5.0
08:19:30	1.64	16.01	1626	191	234	2.0	5.0
08:20:00	1.58	16.09	1632	208	235	1.4	5.0
08:20:30	1.50	16.19	1644	196	236	2.4	5.0
08:21:00	1.65	16.07	1636	236	229	2.5	5.0
08:21:30	1.68	16.10	1634	265	228	2.0	5.0
08:22:00	1.62	16.21	1640	239	232	2.5	5.0
08:22:30	1.67	16.14	1635	250	229	2.5	5.0
08:23:00	1.69	16.12	1637	261	230	3.2	5.0
08:23:30	1.61	16.22	1647	286	230	2.0	5.0
08:24:00	1.58	16.25	1648	235	231	1.8	4.9
08:24:30	1.62	16.20	1644	232	231	3.7	4.9
08:25:00	1.83	16.06	1637	287	227	1.3	4.9
08:25:30	2.06	15.97	1609	190	242	0.8	5.0
08:26:00	2.13	15.95	1588	155	242	1.3	5.0
08:26:30	2.12	15.95	1594	176	238	0.7	5.0
08:27:00	2.27	15.89	1587	151	239	0.5	5.0
08:27:30	2.29	15.86	1578	138	245	0.5	5.0
08:28:00	2.25	15.90	1579	143	244	0.8	5.0
08:28:30	2.29	15.85	1577	156	240	1.5	4.9
08:29:00	2.33	15.85	1574	185	237	1.1	4.9
08:29:30	2.23	15.91	1585	174	241	0.6	4.9
08:30:00	2.19	15.92	1581	148	245	1.0	4.9
08:30:30	2.27	15.77	1572	157	233	0.9	4.9
08:31:00	2.27	15.88	1573	166	237	0.5	4.9
08:31:30	2.04	15.99	1586	145	245	1.6	4.9
08:32:00	2.38	15.72	1566	186	239	1.2	4.9
08:32:30	2.36	15.81	1564	196	241	0.6	4.9
08:33:00	2.26	15.84	1570	160	239	0.8	4.9
08:33:30	2.28	15.82	1569	163	242	1.3	4.9
08:34:00	2.28	15.80	1571	186	237	0.7	4.9
08:34:30	2.23	15.87	1571	164	242	1.0	4.9
08:35:00	2.25	15.76	1574	167	239	1.1	4.9
08:35:30	2.38	15.77	1566	172	240	0.5	4.9
08:36:00	2.11	15.90	1580	143	243	1.1	4.9
08:36:30	2.16	15.85	1575	177	240	1.0	4.9
08:37:00	2.16	15.86	1577	173	240	0.7	4.9
08:37:30	2.14	15.87	1580	158	242	0.9	4.9
08:38:00	2.17	15.87	1573	167	242	0.3	4.9
08:38:30	2.32	15.63	1553	127	259	0.1	4.9
08:39:00	3.82	14.56	1412	85	269	0.3	4.9
08:39:30	4.35	14.20	1361	89	263	0.1	5.0
08:40:00	4.57	14.14	1349	85	267	0.1	5.0
08:40:30	4.49	14.16	1342	85	269	0.0	5.0
08:41:00	4.44	14.17	1337	83	267	0.1	5.0

CAPE BRETON DEVELOPMENT CORPORATION
MINAS BASIN PULP AND POWER
BOILER #7 CWF
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08:04:09 OPERATOR REDUCING AIR IN STEPS
08:57:47 8:56:30 OPEN 3 AIR
09:08:56 CLOSED 3 DAMPER 9:07:30
09:19:31 THE END

TIME	O2	CO2	SO2-2	CO	NOx	THC	FLOW
08:41:30	4.57	14.02	1336	84	264	0.2	5.0
08:42:00	4.72	14.00	1331	85	262	0.1	5.0
08:42:30	4.77	14.12	1337	83	264	-0.0	5.0
08:43:00	4.80	14.07	1334	80	267	0.2	5.0
08:43:30	4.82	14.01	1329	83	263	0.1	5.0
08:44:00	4.75	14.13	1342	84	264	0.2	5.0
08:44:30	4.82	13.99	1333	81	268	-0.1	5.0
08:45:00	4.66	14.21	1342	79	274	0.0	5.0
08:45:30	4.85	13.99	1333	79	265	0.0	5.0
08:46:00	4.99	13.92	1321	82	262	-0.0	5.0
08:46:30	4.81	14.04	1330	78	269	-0.1	5.0
08:47:00	4.98	13.88	1327	80	264	0.0	5.0
08:47:30	4.95	14.01	1321	79	268	-0.1	5.0
08:48:00	4.88	13.96	1323	77	271	0.1	5.0
08:48:30	5.09	13.85	1315	79	265	0.0	5.0
08:49:00	4.98	13.92	1319	77	266	-0.1	5.0
08:49:30	5.02	13.84	1317	77	266	0.1	5.0
08:50:00	5.01	13.83	1312	79	264	0.0	5.0
08:50:30	4.88	13.92	1323	78	263	0.0	5.0
08:51:00	4.88	13.94	1321	78	266	-0.1	5.0
08:51:30	5.02	13.86	1312	78	265	-0.1	5.0
08:52:00	5.06	13.86	1309	73	272	-0.0	5.0
08:52:30	5.17	13.73	1296	72	271	0.1	5.0
08:53:00	5.26	13.64	1282	75	268	0.0	5.0
08:53:30	5.20	13.69	1286	74	273	0.0	5.0
08:54:00	5.13	13.71	1292	83	269	0.0	5.0
08:54:30	5.11	13.80	1296	73	268	-0.2	5.0
08:55:00	4.94	13.98	1311	74	272	-0.0	5.0
08:55:30	4.99	13.83	1306	72	268	-0.1	5.0
08:56:00	5.06	13.80	1303	73	266	-0.1	5.0
08:56:30	5.10	13.86	1302	72	268	-0.1	5.0
08:57:00	5.04	13.86	1305	73	269	-0.3	4.9
08:57:47	4.53	14.40	1338	63	370	-0.2	4.9
08:58:00	4.30	14.45	1335	55	417	-0.4	4.9
08:58:30	4.18	14.54	1351	54	417	-0.4	5.0
08:59:00	4.22	14.49	1342	53	423	-0.4	5.1
08:59:30	4.28	14.44	1339	53	434	-0.5	5.1
09:00:00	4.28	14.48	1340	53	436	-0.5	5.1
09:00:30	4.28	14.47	1344	51	437	-0.5	5.1
09:01:00	4.37	14.45	1339	52	438	-0.5	5.1
09:01:30	4.34	14.45	1338	50	435	-0.5	5.1
09:02:00	4.46	14.40	1334	50	440	-0.4	5.1
09:02:30	4.43	14.39	1330	49	440	-0.5	5.1
09:03:00	4.40	14.48	1336	48	444	-0.5	5.1
09:03:30	4.37	14.45	1340	48	439	-0.5	5.1
09:04:00	4.36	14.46	1336	49	442	-0.4	5.0
09:04:30	4.36	14.43	1339	49	449	-0.5	5.0

← open tertiary damper

CAPE BRETON DEVELOPMENT CORPORATION
MINAS BASIN PULP AND POWER
BOILER #7 CWF
11-10-1988

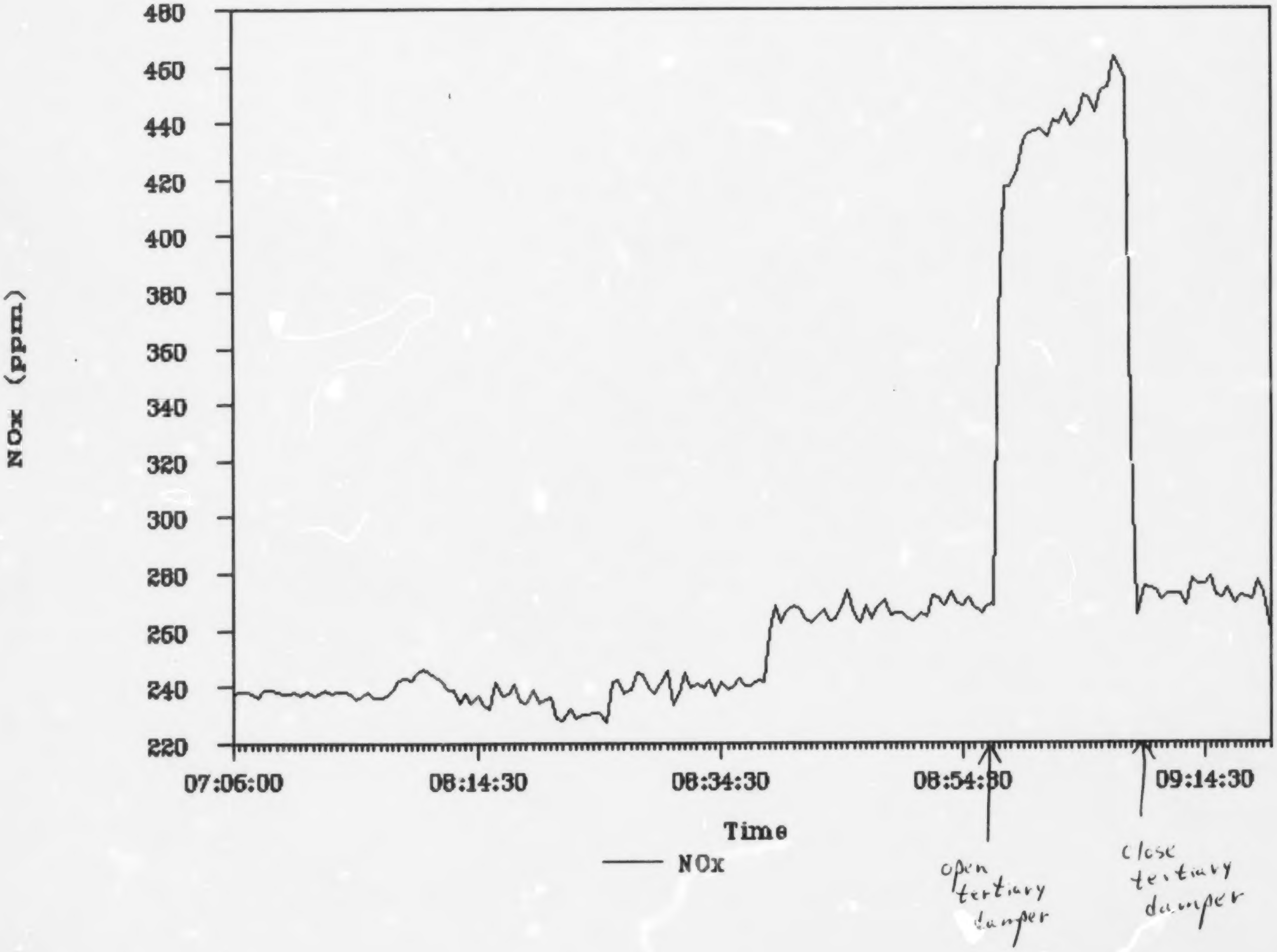
08:04:09 OPERATOR REDUCING AIR IN STEPS
08:57:47 8:56:30 OPEN 3 AIR
09:08:56 CLOSED 3 DAMPER 9:07:30
09:19:31 THE END

TIME	O2	CO2	SO2-2	CO	NOx	THC	FLOW
09:05:00	4.35	14.45	1340	47	448	-0.5	5.0
09:05:30	4.34	14.42	1336	48	444	-0.4	5.0
09:06:00	4.35	14.45	1332	48	451	-0.5	5.0
09:06:30	4.34	14.46	1338	48	452	-0.5	5.0
09:07:00	4.32	14.47	1347	48	463	-0.4	5.0
09:07:30	4.35	14.45	1342	47	460	-0.4	5.0
09:08:00	4.47	14.36	1332	47	455	-0.3	5.0
09:08:30	4.88	13.93	1306	54	329	-0.1	5.0
09:09:00	5.33	13.75	1294	66	265	0.1	5.0
09:09:30	5.13	13.95	1312	66	276	-0.2	5.0
09:10:00	5.08	13.85	1309	64	275	-0.1	5.0
09:10:30	5.27	13.76	1301	66	274	-0.1	5.0
09:11:00	5.30	13.67	1289	67	270	-0.1	5.0
09:11:30	5.27	13.81	1299	66	273	-0.0	5.0
09:12:00	5.10	13.91	1308	66	273	-0.3	5.0
09:12:30	5.19	13.82	1297	65	273	-0.1	5.0
09:13:00	5.30	13.68	1292	68	269	-0.2	5.0
09:13:30	5.19	13.83	1298	64	278	-0.1	5.0
09:14:00	5.18	13.77	1304	65	276	-0.1	5.0
09:14:30	5.05	13.93	1306	66	276	-0.2	5.0
09:15:00	5.04	13.88	1311	65	279	-0.1	5.0
09:15:30	5.26	13.71	1295	65	272	0.0	5.0
09:16:00	5.39	13.68	1289	68	271	0.0	5.0
09:16:30	5.23	13.73	1297	66	275	0.0	5.0
09:17:00	5.50	13.53	1279	68	269	-0.0	5.0
09:17:30	5.45	13.61	1282	67	272	0.0	5.0
09:18:00	5.38	13.68	1283	67	271	0.1	5.0
09:18:30	5.43	13.60	1280	68	271	-0.0	4.9
09:19:00	5.32	13.70	1284	65	277	-0.0	4.9
09:19:31	5.28	13.77	1286	67	272	0.2	4.9
09:20:00	5.45	12.81	1257	66	259	1.5	5.3

← Close Tertiary Damper

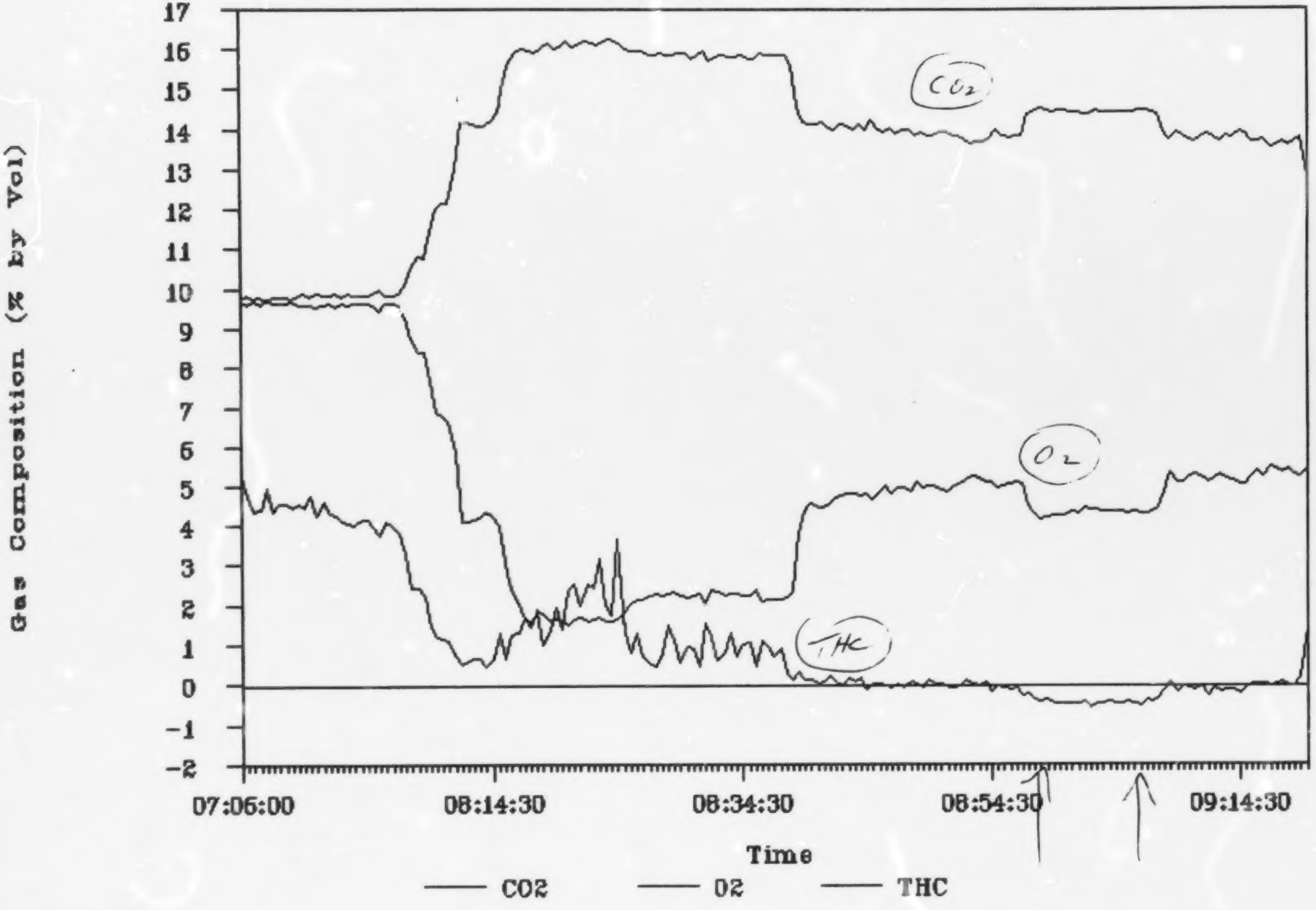
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



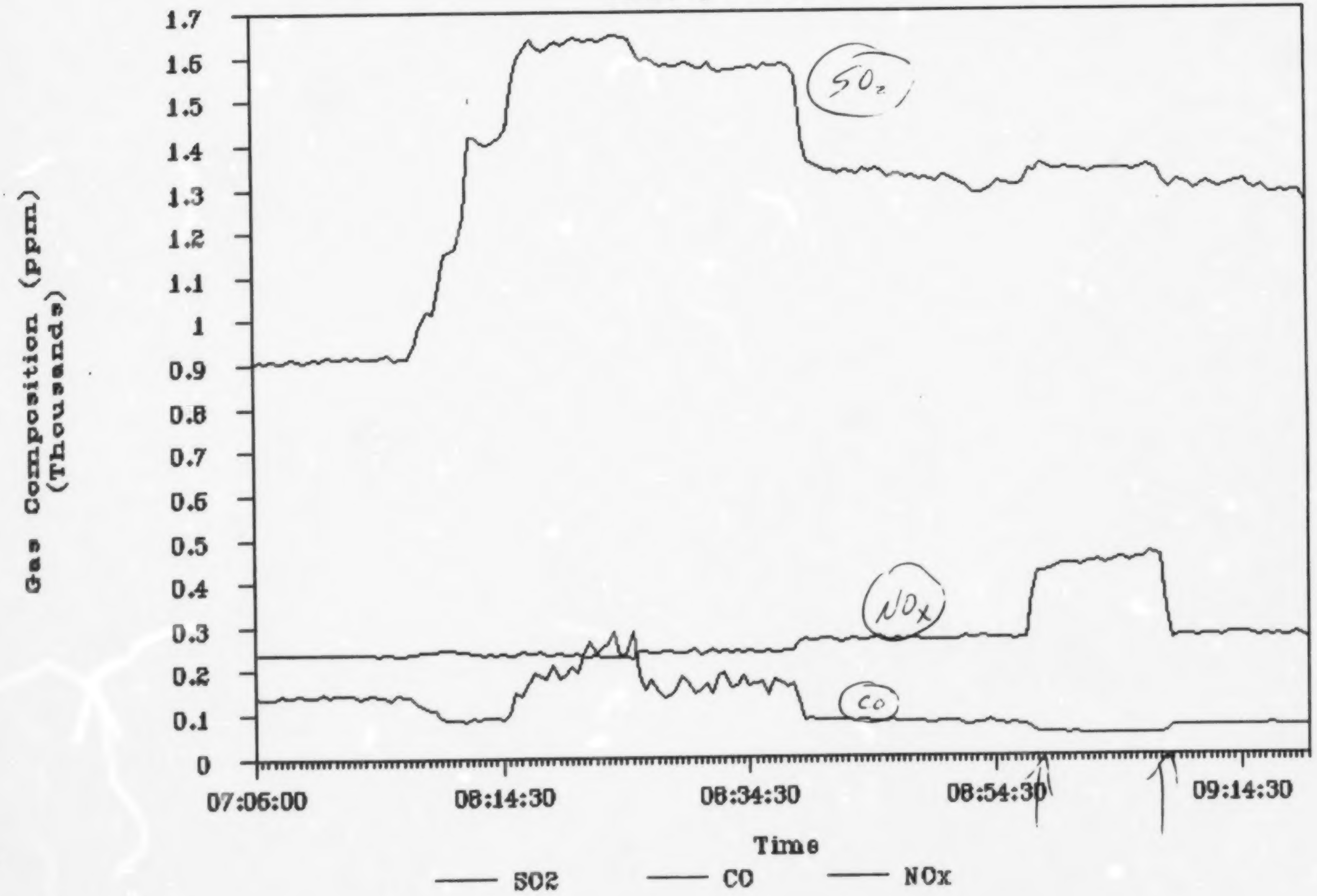
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



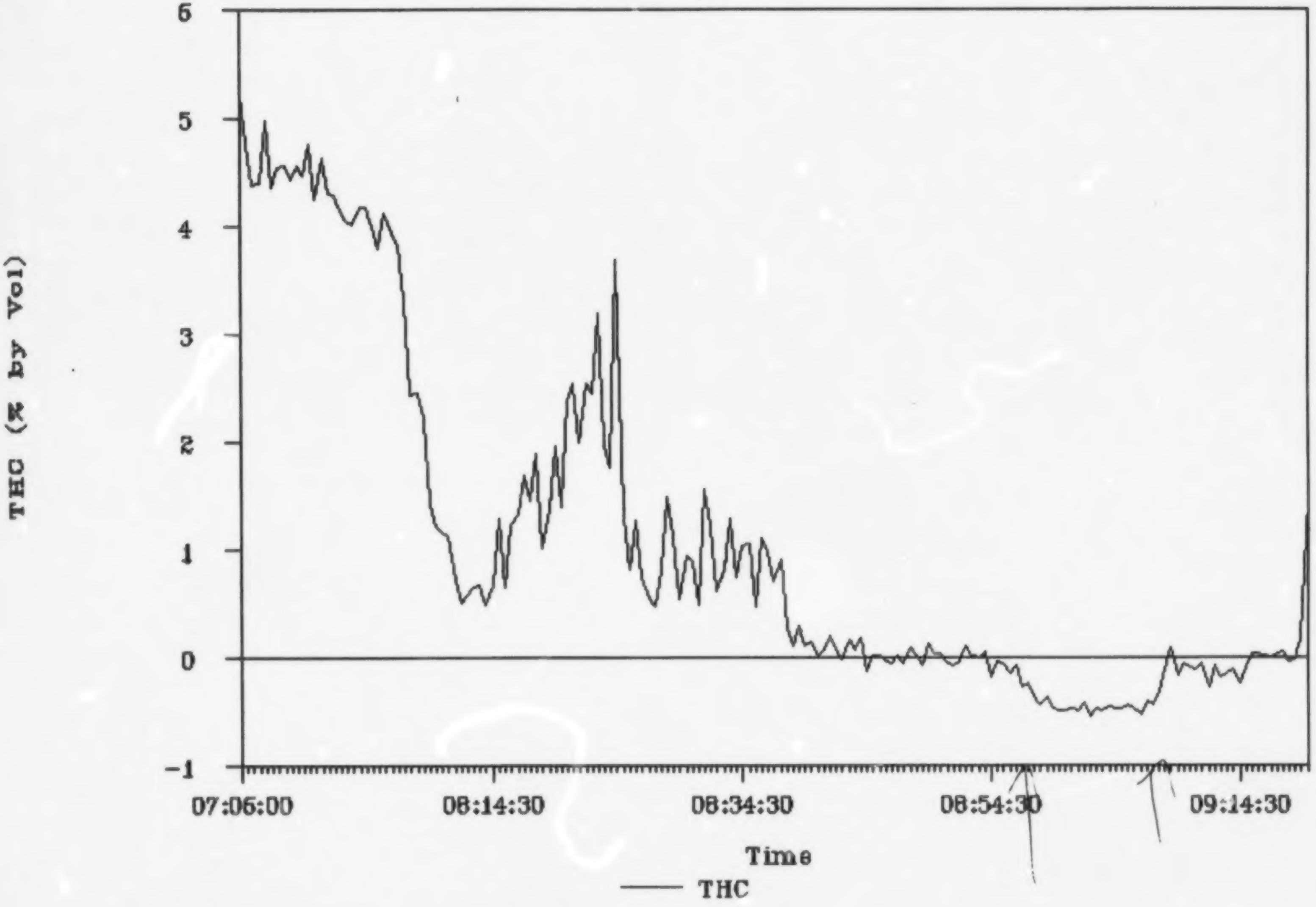
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



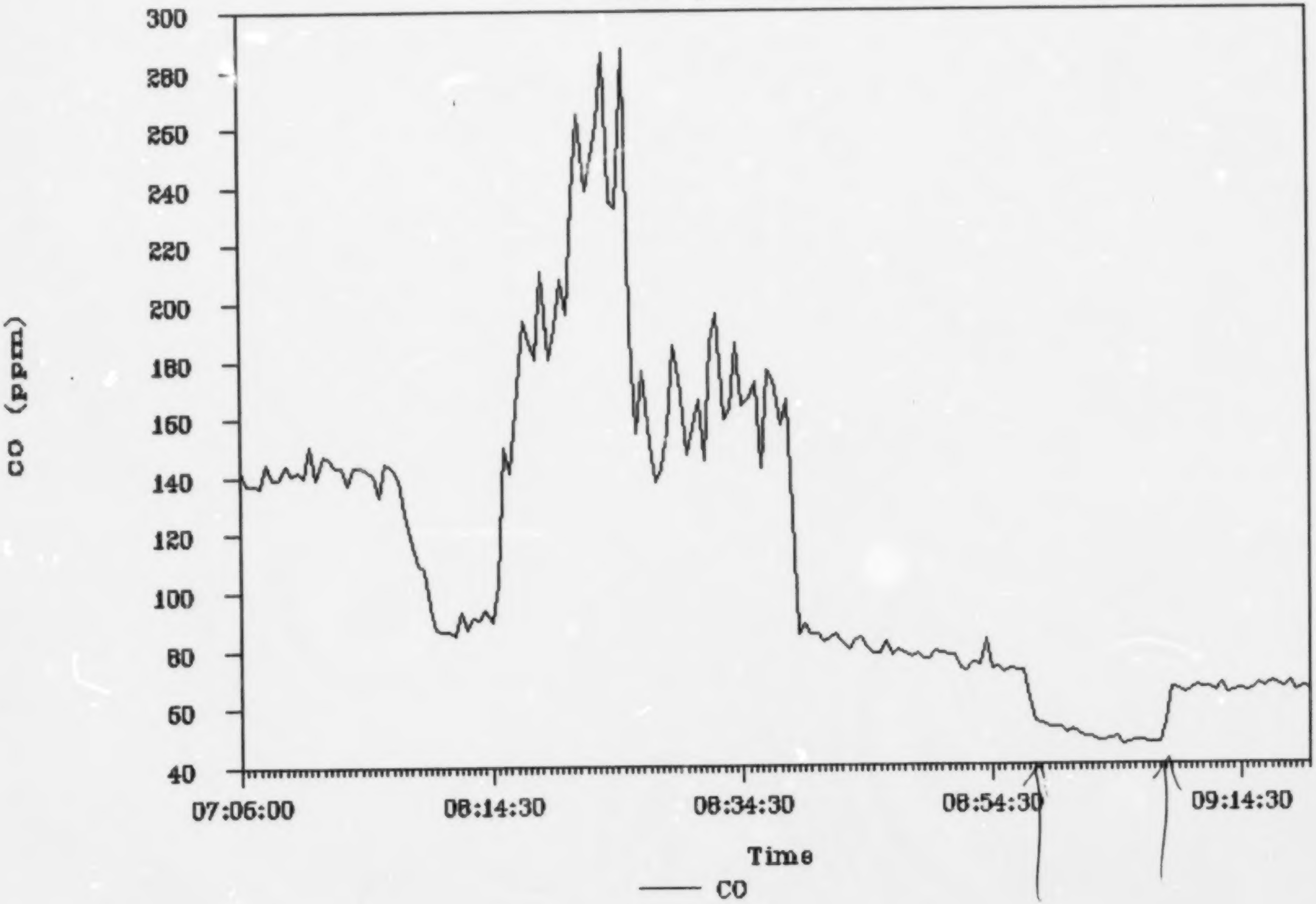
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



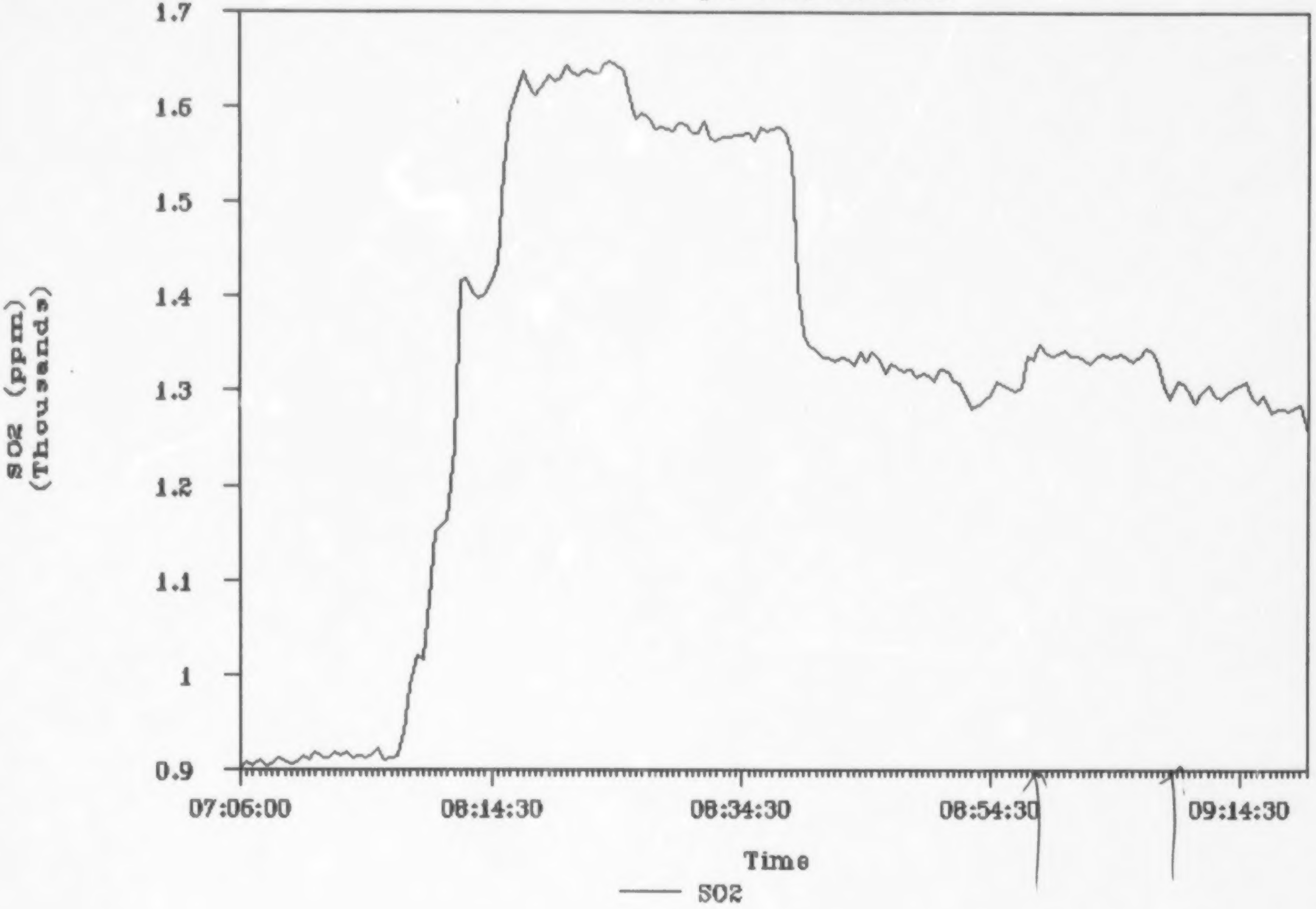
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



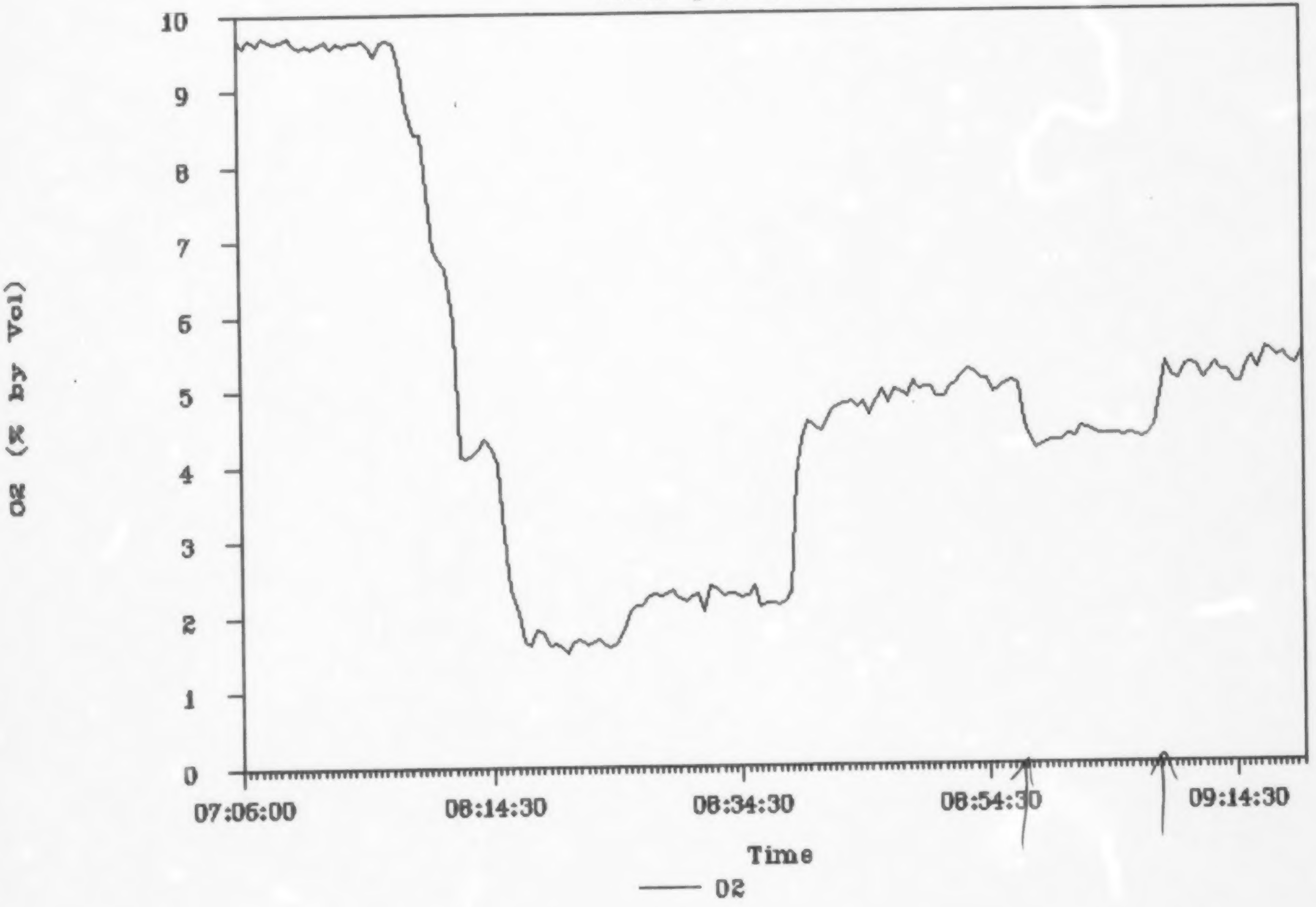
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



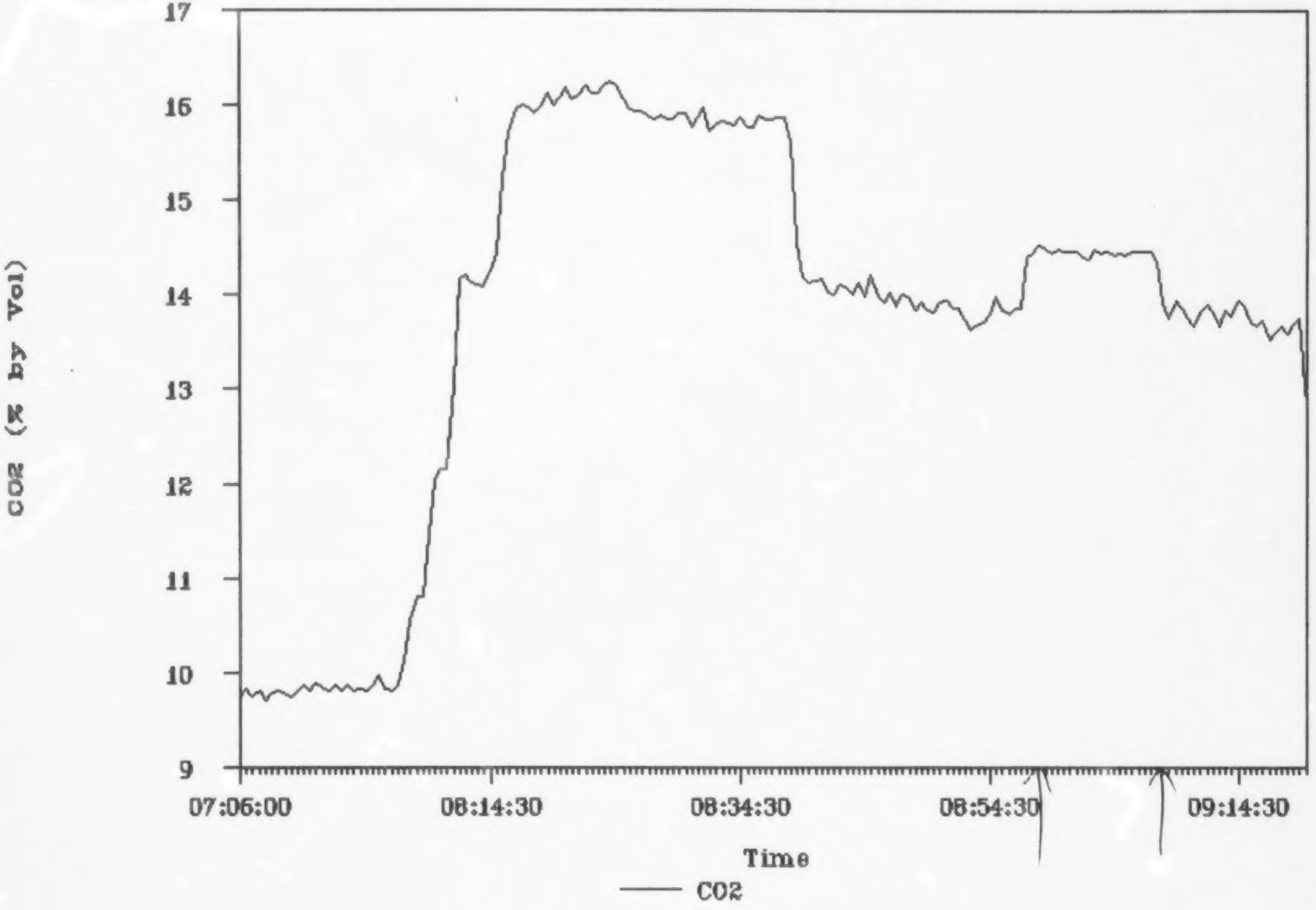
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



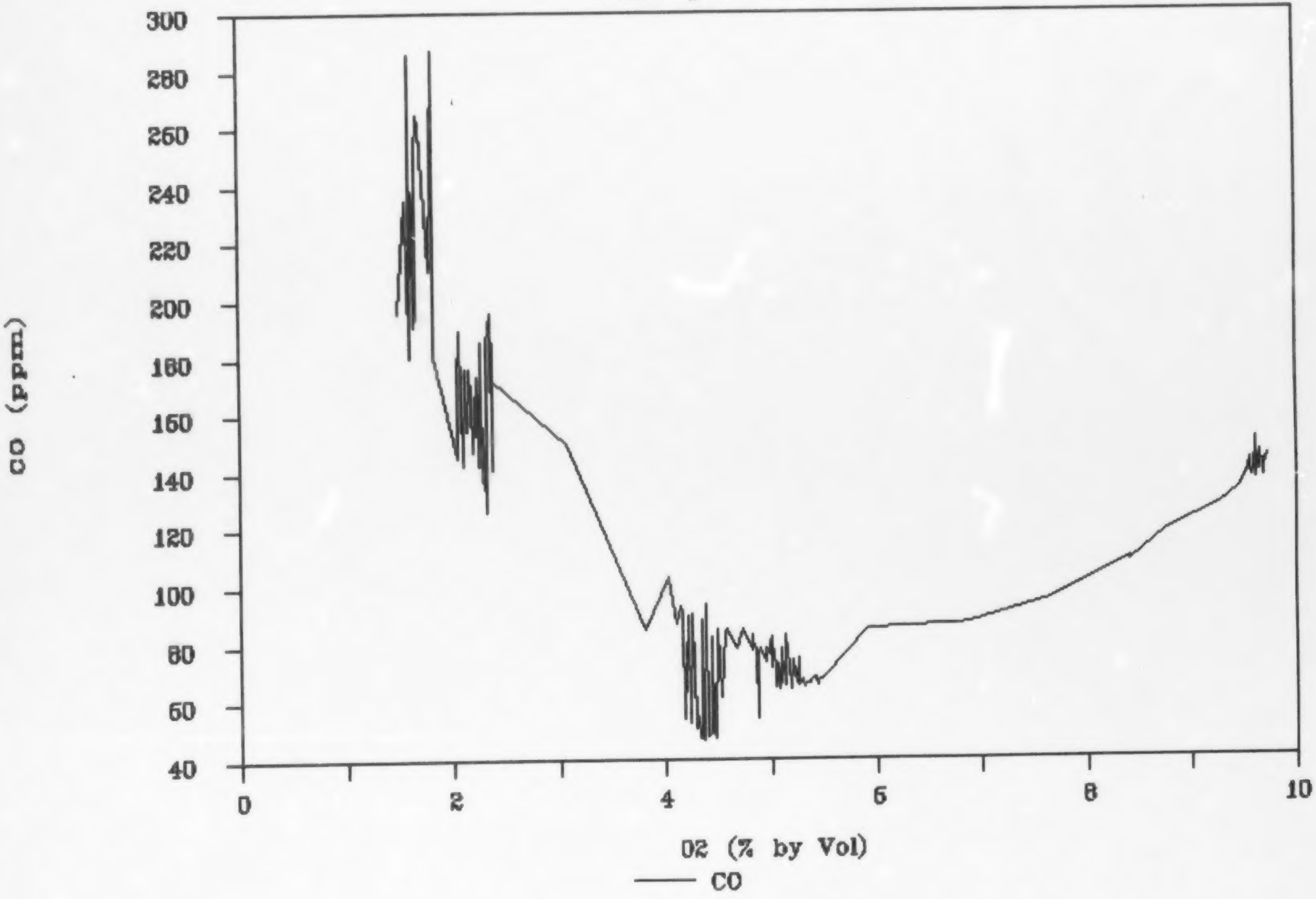
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



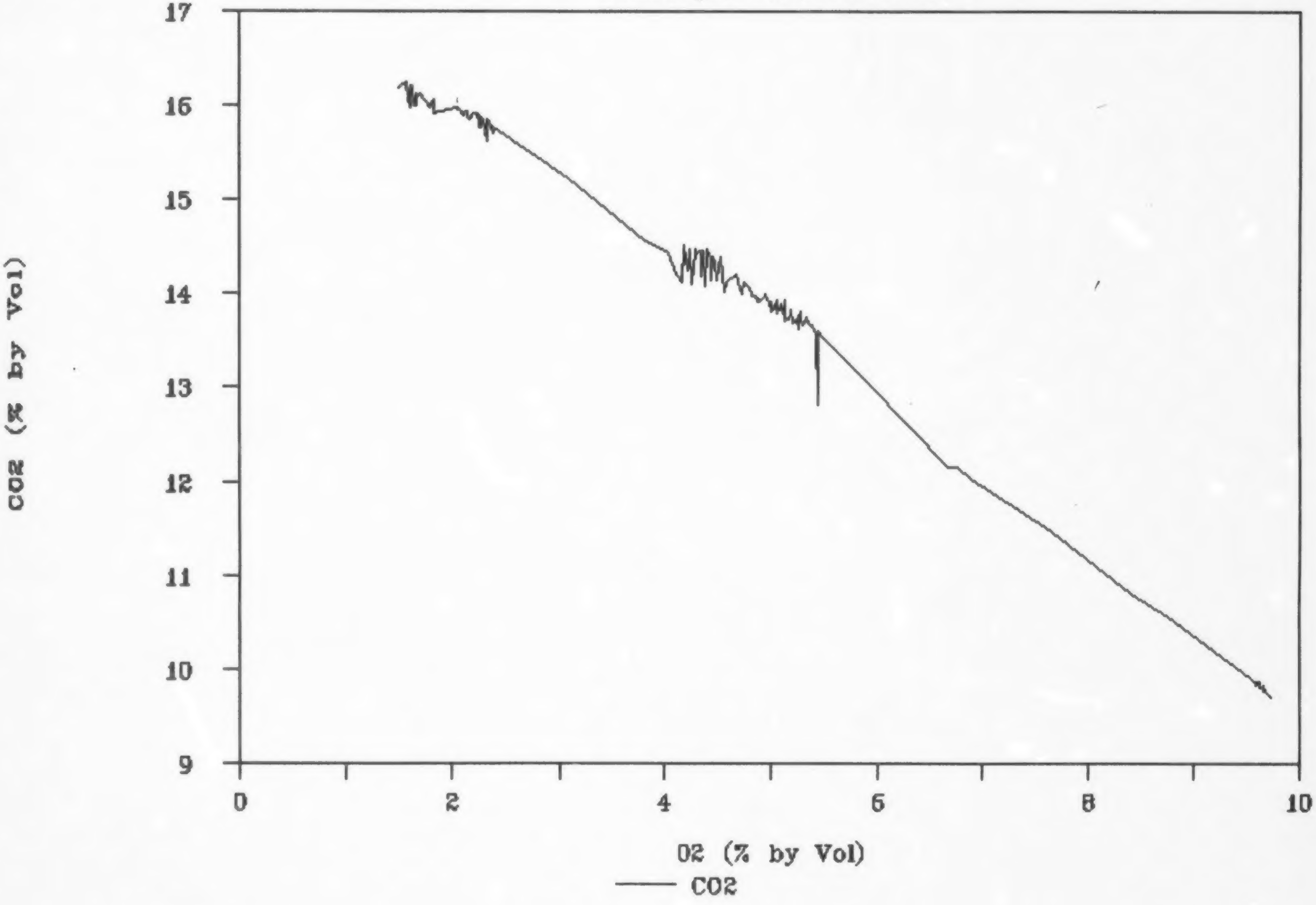
MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



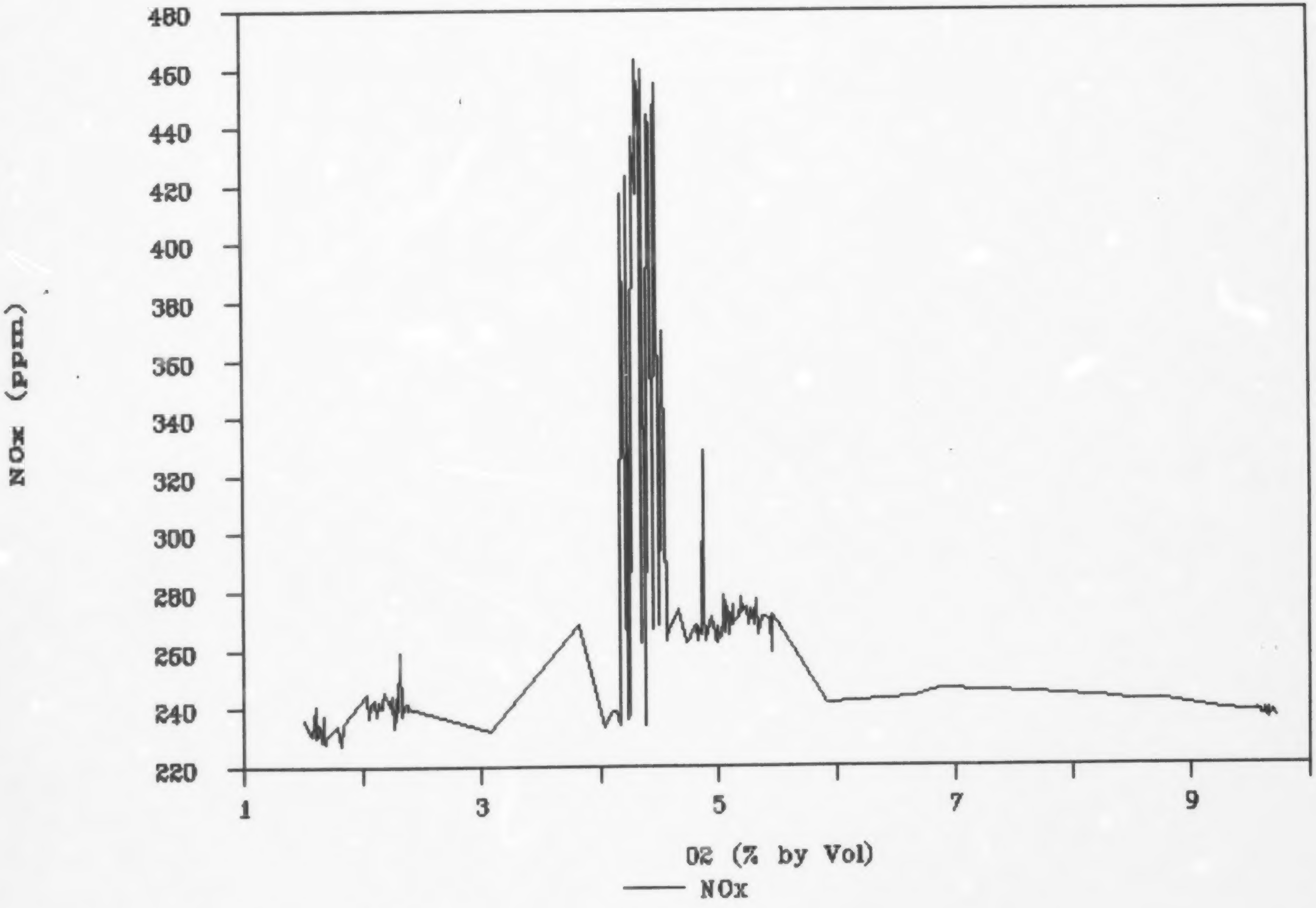
MINAS BASIN PULP AND POWER

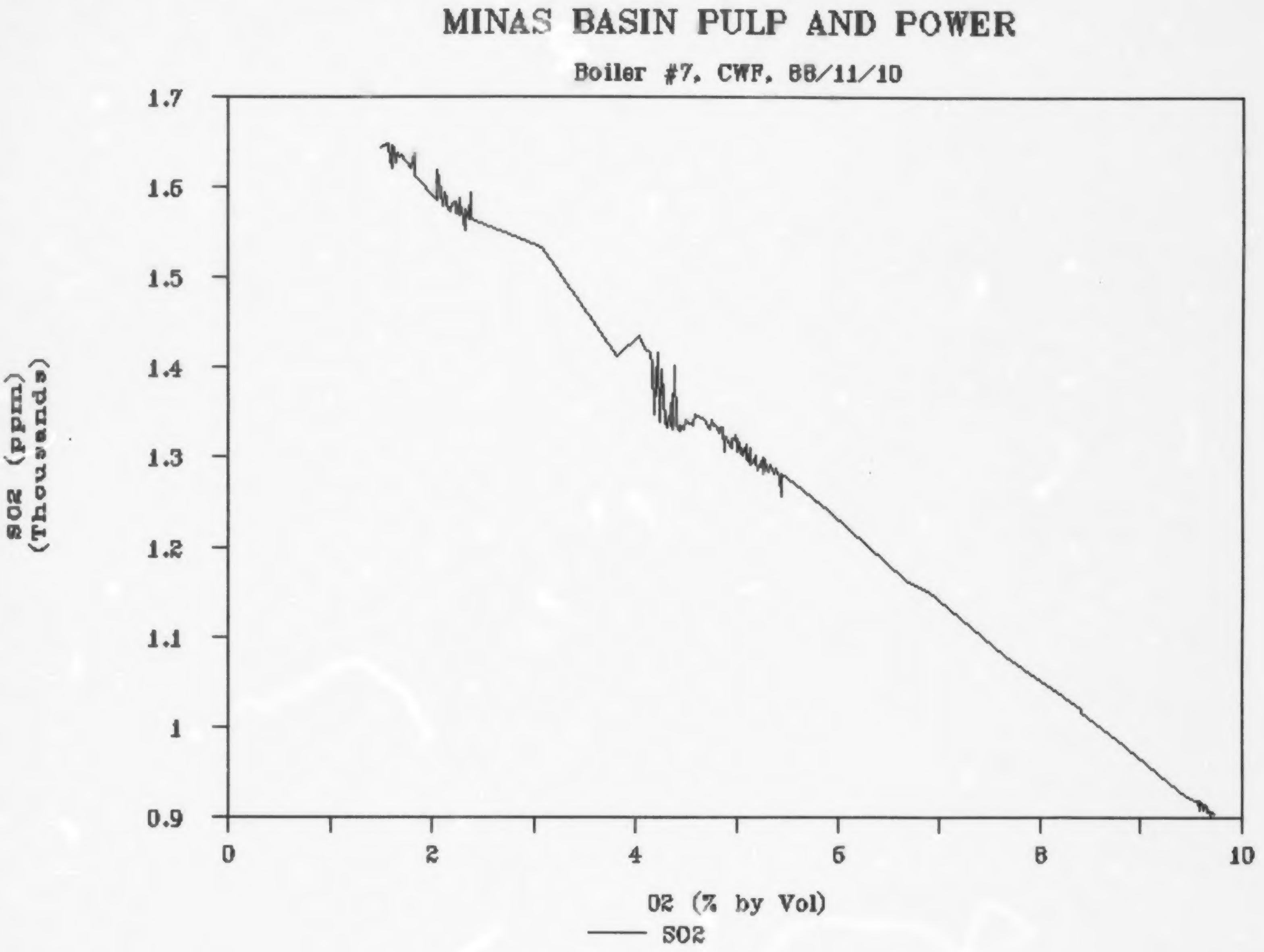
Boiler #7, CWF, 88/11/10



MINAS BASIN PULP AND POWER

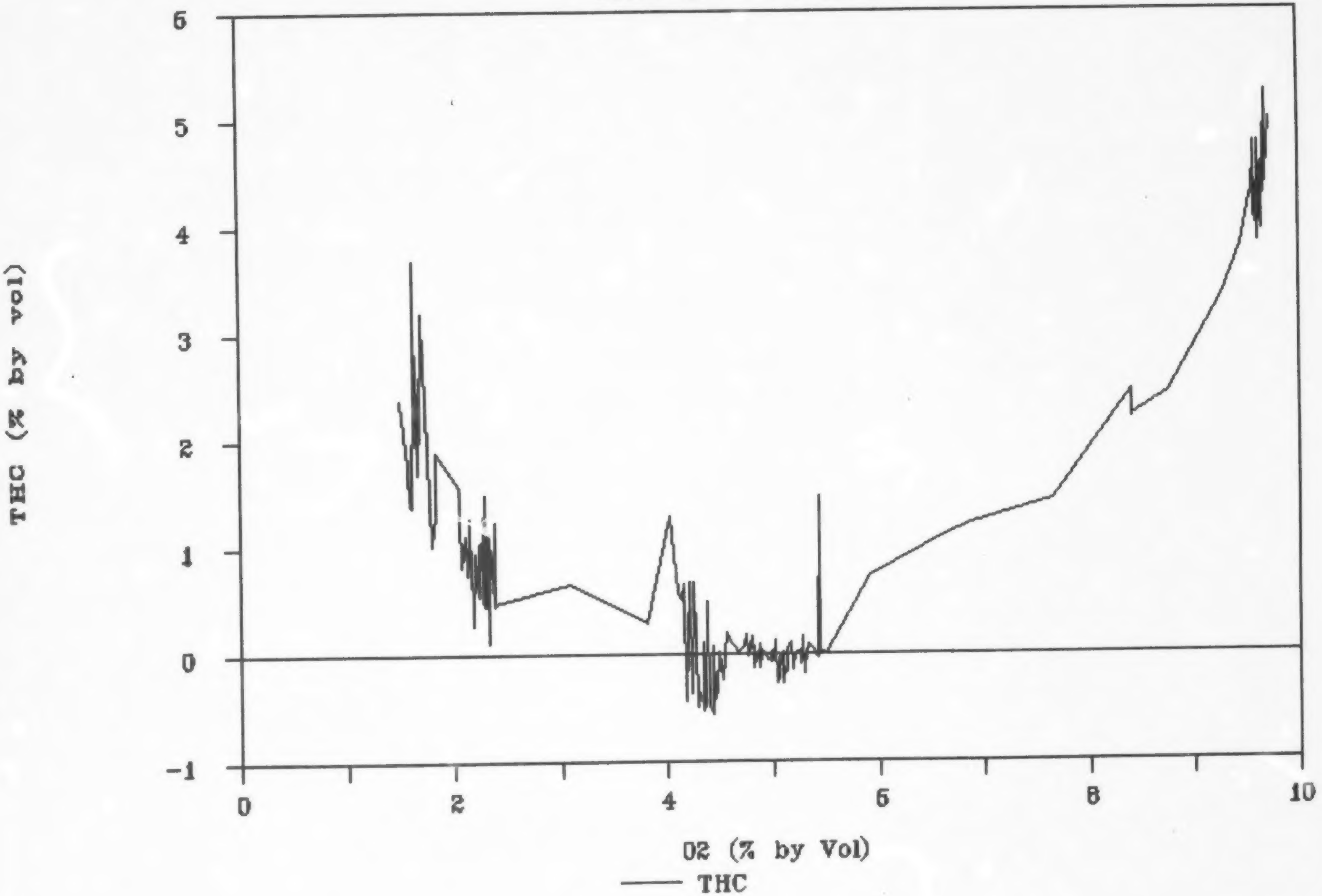
Boiler #7, CWF, 88/11/10




MINAS BASIN PULP AND POWER
Boiler #7, CWF, 88/11/10
SO2 (ppm)
(Thousands)
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0
2
4
6
8
10
O2 (% by Vol)
SO2

MINAS BASIN PULP AND POWER

Boiler #7, CWF, 88/11/10



APPENDIX N

CWF DELIVERY RECORDS AND ANALYSIS

MINAS BASIN FUEL SHIPMENT ANALYSES

DATE	TONNAGE	ASH	SULFUR	BTU	MOISTURE
88-04-06	31.80				
88-04-07	31.60		1.15	10273	30.04
88-04-08	31.50				
TOTAL	94.90				
88-05-06	31.82	2.39	1.16	10183	30.27
88-05-08	31.82	2.42	1.21	10141	30.92
88-05-10	31.60	2.41	1.16	10094	30.84
88-05-11	31.60	2.40	1.15	10190	30.15
88-05-12	31.70	2.39	1.18	10162	30.60
88-05-13	31.90	2.39	1.20	10213	30.78
88-05-13	31.40	2.33	1.18	10222	30.20
88-05-14	31.90	2.33	1.16	10228	30.21
88-05-15	31.90	2.34	1.15	10239	30.13
88-05-16	31.50	2.37	1.20	10051	30.95
88-05-18	30.30	2.44	1.16	10335	29.40
88-05-20	31.70	2.56	1.32	9836	30.25
88-05-24	31.40	2.39	1.18	10378	29.90
88-05-25	31.80	2.28	1.20	10315	29.90
88-05-26	31.30	2.21	1.19	10339	29.95
88-05-27	31.70	2.27	1.21	10232	30.04
88-05-30	31.70	2.32	1.21	10225	29.94
TOTAL	537.04				
88-06-03	31.70	2.02	1.17	10559	29.60
88-06-04	31.90	2.02	1.22	10513	30.00
88-06-05	32.00	2.07	1.17	10560	29.97
88-06-06	31.40	2.20	1.19	10512	30.08
88-06-07	31.60	2.14	1.20	10565	30.05
88-06-07	31.60	1.97	1.15	10550	30.14
88-06-08	31.50	2.05	1.16	10510	30.07
88-06-09	31.50	1.99	1.15	10488	30.55
88-06-10	31.90	2.20	1.21	10520	30.22
88-06-11	31.90	1.95	1.16	10518	29.96
88-06-13	31.90	1.94	1.18	10604	30.12
88-06-13	31.60	1.94	1.19	10487	30.09
88-06-14	31.20	2.02	1.14	10599	30.06
88-06-15	31.40	1.81	1.18	10583	30.05
88-06-15	31.70	2.99	1.46	10266	31.00
88-06-16	31.80	3.03	1.48	10335	30.70
88-06-17	31.70	2.85	1.48	10271	30.90
88-06-20	31.60	3.35	1.70	10280	30.72
88-06-20	31.60	2.87	1.41	10372	30.74
88-06-21	31.60	2.85	1.42	10457	30.06
88-06-22	31.90	3.54	1.64	10188	31.13
88-06-23	31.90	3.37	1.60	10189	31.00
88-06-24	31.60	2.85	1.42	10254	31.71
88-06-27	32.10	2.78	1.37	10309	30.73
88-06-29	31.70	2.69	1.40	10402	30.14
88-06-30	31.70	2.74	1.32	10334	30.71
TOTAL	824.00				

DATE	TONNAGE	ASH	SULFUR	BTU	MOISTURE
88-07-04	31.60	3.29	1.51	10353	30.17
88-07-06	31.90	3.43	1.61	10377	30.16
88-07-07	31.70	3.74	1.69	10319	30.21
88-07-08	32.20	3.60	1.68	10379	30.07
88-07-11	31.50	3.50	1.66	10415	30.04
88-07-12	31.50	3.44	1.58	10385	30.01
88-07-13	31.70	3.81	1.72	10233	30.02
88-07-14	31.50	3.81	1.73	10335	30.31
88-07-27	31.80	3.48	1.62	10427	30.22
TOTAL	285.40				
88-08-02	31.00	3.80	1.74	10289	30.27
88-08-03	30.70	3.83	1.76	10375	30.15
88-08-04	31.30	3.51	1.66	10189	30.68
88-08-05	31.30	3.52	1.68	10188	30.62
88-08-08	31.50	3.65	1.69	10255	30.07
88-08-10	31.60	3.48	1.64	10333	30.82
88-08-11	31.60	3.62	1.64	10364	30.20
88-08-12	31.40	3.60	1.63	10234	30.[illegible]
88-08-17	31.70	3.54	1.60	10198	30.1[illegible]
88-08-18	31.60	3.57	1.62	10305	30.08
88-08-19	31.60	3.60	1.66	10264	30.67
88-08-22	31.30	3.58	1.66	10290	30.37
88-08-23	31.80	3.52	1.66	10148	30.77
88-08-24	31.70	3.50	1.67	10292	30.70
88-08-25	31.10	3.44	1.60	10155	30.15
88-08-26	30.60	3.37	1.62	10352	30.09
88-08-26	30.90	3.43	1.60	10306	30.90
88-08-29	31.30	3.54	1.66	10372	30.33
88-08-30	31.20	3.58	1.64	10306	30.80
88-08-31	31.60	3.46	1.63	10386	30.18
TOTAL	626.80				
88-09-01	31.60	3.40	1.64	10313	30.77
88-09-02	31.60	3.47	1.64	10365	30.20
88-09-06	31.40	3.30	1.64	10321	30.76
88-09-08	31.60	3.54	1.62	10320	30.80
88-09-08	31.90	3.42	1.64	10311	30.82
88-09-09	31.70	3.40	1.64	10330	30.88
88-09-10	31.50	3.52	1.62	10291	30.74
88-09-11	31.40	3.42	1.64	10338	30.95
88-09-12	31.80	3.50	1.64	10314	30.87
88-09-14	31.60	3.49	1.62	10313	30.82
88-09-14	31.50	3.38	1.62	10238	30.70
88-09-16	31.40	3.47	1.56	10256	30.29
88-09-17	31.40	3.40	1.58	10265	30.38
88-09-18	31.60	3.40	1.58	10265	30.38
88-09-19	31.60	3.33	1.60	10277	30.46
88-09-19	31.30	3.19	1.60	10383	30.75
88-09-20	31.60	3.35	1.60	10251	30.74
88-09-20	31.50	3.41	1.59	10292	30.32
88-09-22	31.40	3.75	1.60	10338	30.25

DATE	TONNAGE	ASH	SULFUR	BTU	MOISTURE
88-09-24	31.40	3.54	1.61	10402	30.22
88-09-26	31.50	3.62	1.65	10358	30.21
88-09-26	31.40	3.69	1.70	10314	30.20
88-09-27	31.40	3.67	1.70	10348	30.21
88-09-28	31.30	3.83	1.72	10363	30.27
88-09-29	31.20	3.67	1.68	10269	30.33
88-09-30	31.30	3.48	1.57	10226	30.69
TOTAL	818.90				
88-10-01	31.50	3.64	1.68	10263	30.83
88-10-02	31.50	3.67	1.68	10276	30.72
88-10-03	31.30	3.65	1.67	10172	30.70
88-10-06	31.50	3.67	1.69	10172	30.10
88-10-06	31.50	3.51	1.68	10055	30.22
88-10-07	31.50	3.50	1.70	10225	30.13
88-10-14	30.90	3.32	1.71	10278	30.16
88-10-18	30.60	3.48	1.70	10058	30.38
88-10-21	31.40	3.55	1.67	10148	30.32
88-10-22	31.50	4.08	1.89	10062	30.13
88-10-23	31.50	3.58	1.65	9894	31.89
88-10-24	30.90	3.62	1.69	10172	30.14
88-10-25	31.40	4.05	1.94	10140	30.12
88-10-27	31.60	4.30	1.99	9910	30.16
88-10-28	31.60	4.11	1.97	9984	30.01
TOTAL	470.20				
88-11-01	31.40	4.40	1.96	10057	30.05
88-11-02	31.20	4.37	1.98	10127	30.18
88-11-03	31.00				
88-11-04	31.00				
TOTAL	124.6				

TOTAL TONNAGE SHIPPED TO 88-11-04 3781.84

*BTU REPORTED ON AS RECEIVED BASIS

APPENDIX O

CERAMIC WEAR RECORDS

The NRC Wear-Resistant CSF Atomizer

- ADVANCED CERAMICS DEVELOPMENT -

January 1989

The use of ceramic wear components in CSF burner tips has been advocated by NRC since the 1978 EMR coal-oil mixture demonstration in NBEPC's Chatham Unit 1. In these "early" days various metallic alloys as well as alumina were fabricated into inserts for retrofit into existing internal mix oil atomizers. The outcome of this work showed that the use of ceramic components was necessary to alleviate the high degree of wear these conventional atomizers were undergoing.

In-house studies during the early 1980's identified high density/high purity alumina as a candidate material for CSF burner tip wear components. The NRC CSF atomizer, in its earlier versions, exclusively used alumina for its wear resistant components. The two co-axially mounted ring and cone wear components have proven useful in alleviating the erosive wear associated with the atomization of CSF as had been demonstrated in spray testing with coal-oil-mixtures as well as short duration flame tunnel combustion testing. In fact, a single CSF atomizer wear-piece fashioned from alumina for Canada Cement Lafarge has been in service at a Richmond, B.C. cement kiln since its installation in June 1984. However, field experience with the NRC CSF atomizer has identified other properties of alumina which can in certain situations prove to be unsatisfactory. To evaluate different materials for suitability in this application, thermal shock resistance, toughness, and erosion resistance were defined as the three most important properties.

Thermal shock resistance, simply put, is the ability of the material to withstand stresses generated by large temperature differences without generating flaws which could lead to catastrophic failure. For structural ceramics, the thermal shock resistance is related to both material type and processing technique, with the final porosity and grain structure playing interactive roles in the initiation of flaws.

Toughness is the ability of a material to absorb energy and undergo plastic deformation without fracturing. Ceramic toughness is complicated by its dependency on manufacturing procedures.

Erosion resistance has been shown to be related to porosity, grain structure, and toughness. Generally, more porous and larger grained ceramics will exhibit lower erosion resistance

Using the above mentioned parameters as selection criteria, the following materials were chosen as candidates: Si_3N_4, Partially Stabilized Zirconia (PSZ) and PSZ toughened alumina.

During single burner field trials in MECL's unit 10 in Charlottetown, 150 operational hours firing CSF were accumulated for a single set of Si_3N_4 wear components. The resultant wear was unequally divided between the cone and ring. Cone wear was significant and was oriented with the axial dimension of the atomizer while ring wear was minimal and oriented 90 degrees to that of the cone. While no degradation of performance was noted a useful life of approximately 300 hours was estimated for the Si_3N_4 cones. **Of particular note was the absence of material failures of any kind during the trial.** Even through nozzle blockages, unit trips and sometimes abusive operator handling, these components endured without even a crack.

Wear components were fabricated from these various materials by commercial vendo whenever possible, and by in-house fabrication. For example PSZ toughened alumina is still an experimental material and difficult to source from commercial vendors and thus an in-house program to study the optimization of this material was initiated where both fabrication techniques and material composition were varied.

The selection of the NRC CSF atomizer for the Minas Basin Pulp and Power boiler conversion to CSF firing was to provide a long term industrial scale test where various candidate materials could be evaluated. Less than routine operation of the unit to this date has made the interpretation of results somewhat inconsistent. Preliminary results suggest that PSZ toughened alumina is the longest wearing material in this application but further testing is required to establish the optimum composition and favoured fabrication methods.

Tables 1 and 2 list the wear component history for both atomizers used at the Minas Basin Pulp and power site. Although the installation was first fired in April '88, it was not until August when operation was consistent enough to collect reasonable observations regarding the ceramic atomizer inserts. These operational upsets are also reflected in Tables 1 and 2 where results obtained after the October 8 shutdown (for burner modifications) for Si_3N_4 and PSZ were not consistent with those previously acquired.

Table 1. Wear component operational log for Atomizer No.1.

Material	In	Out	Hours	Comments
20% PSZM-Cone Si_3N_4 Ring	Aug.	Sept.6	251	Removed following failure
20% PSZC-Cone Same ring as above	Sept.6	Oct.8	354	Boiler down for mods Ceramics removed 605 for Si_3N_4 ring
Si_3N_4-Cone Si_3N_4-Ring	Oct.17	Nov.7	153 15	Oil firing CWF Removed by CBDC
Si_3N_4-Cone Si_3N_4-Ring	Nov.17	Nov.24		Replaced due to wear
PSZ-Cone	Nov.24			Installed at present

Where: PSZ denotes Partially Stabilized Zirconia, NILCRA Ceramics Inc.
PSZC denotes slip-cast PSZ modified alumina, in-house fabrication.
PSZM denotes isostatically pressed PSZ modified alumina, in-house fabrication.
Si_3N_4 denotes silicon nitride, GTE Wesgo.

At present Si_3N_4 has shown to be the most resilient material in this service having never shown a failure. Based on operation to date, the service life for Si_3N_4 is 500-750 hours for a ring and 300-500 hours for a cone.

As shown in Table 1 our best wearing pieces have been PSZ modified alumina. However, further work is necessary to optimize the fabrication techniques of this material so as to eliminate in service failures. An in-house program to assess the effects of composition and processing variables on the service life for the dual-fuel application continues.

Table 2. Wear component operational log for Atomizer No.2.

Material	In	Out	Hours	Comments
20% PSZC-Cone 20% PSZC-Ring	Aug.1	Aug.22	212	Removed following failure
10% PSZM-Cone 10% PSZM-Ring	Aug.22	Sept.17	276	Removed following failure
Si_3N_4-Cone Si_3N_4-Ring	Sept.17	Oct.8	342	Replaced during shutdown
PSZ-Cone PSZ-Ring	Oct.18	Nov.7	159 99	Oil firing CWF firing
PSZ-Cone PSZ-Ring	Nov.7	Nov.24	61	Total of oil & CWF

Where: PSZ denotes Partially Stabilized Zirconia, NILCRA Ceramics Inc.
PSZC denotes slip-cast PSZ modified alumina, in-house fabrication.
PSZM denotes isostatically pressed PSZ modified alumina, in-house fabrication.
Si_3N_4 denotes silicon nitride, GTE Wesgo.

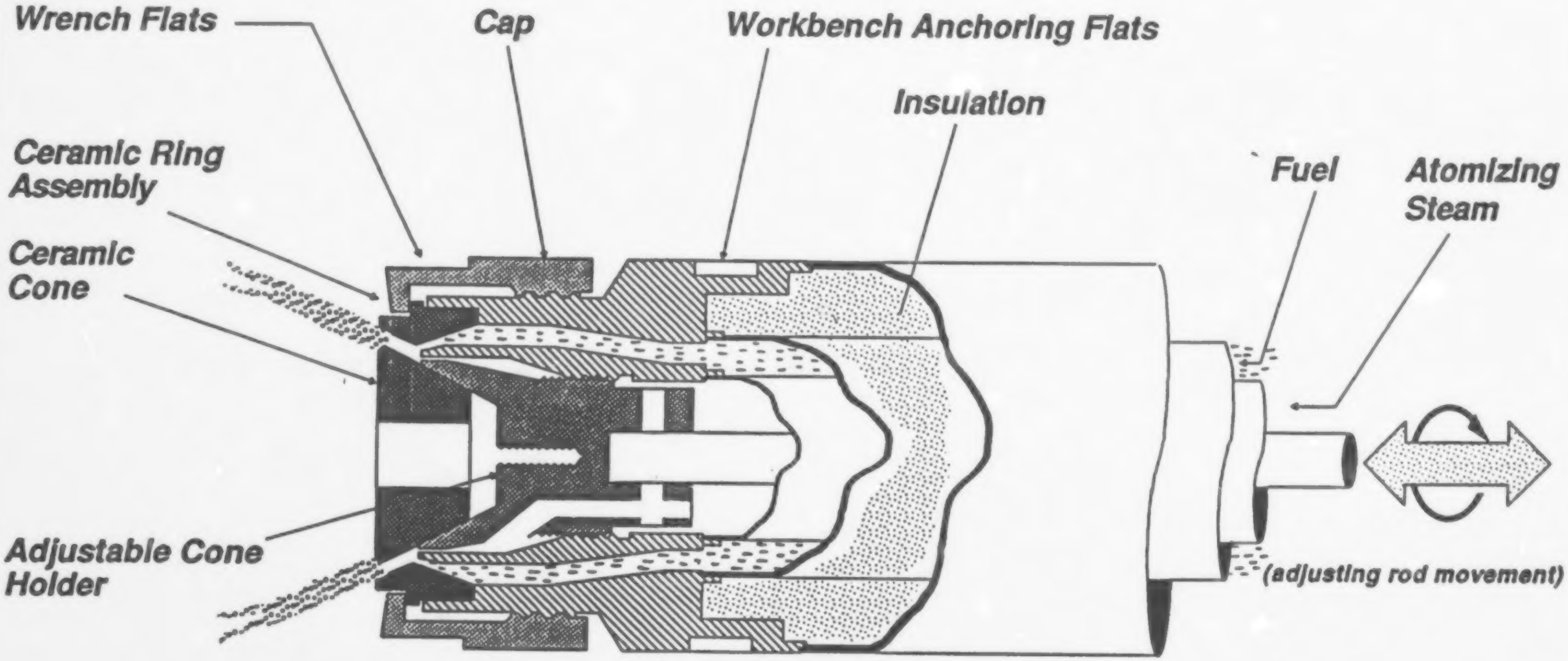

Wrench Flats
Cap
Workbench Anchoring Flats
Insulation
Ceramic Ring Assembly
Ceramic Cone
Adjustable Cone Holder
Fuel
Atomizing Steam
(adjusting rod movement)

Figure 1: *NRC* Dual Fuel Atomizer